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THE Compleat Arithmetician:

Or, the whole Art of

Arithmetick,

VULGAR and DECIMAL,

In a Plain and Easie Method, suitable to the Meanest Capacity.

In which the Multiplication and Division of Numbers of Several Denominations, and the Rule of Alligation are more fully explained than in any Treatise of this Nature, yet Extant.

By *J. N.* Philomath.

LONDON,

Printed for John Taylor at the *Ship*, and Christopher Browne at the *Globe* in S. *Paul's Church-Yard*. MDCXCI.

TO THE

Right Honourable

JOHN Lord Viſcount *SCUDAMORE.*

My Lord,

THough it muſt be acknowledged, that the Latine and Greek tongues are neceſſary qualifications for all Gentlemen and perſons of Honour; yet do I not think them ſo for all perſons of a low degree, eſpecially if the labouring for them ſhall occaſion the neglect of other more uſeful ſtudies in reference

to their livelyhood; and yet attain to ſo little perfection in them, that the very rudiments of them, are in a very little time wholly forgotten alſo; and therefore, methinks, another way of inſtructing youth, than the Latine Grammar ſhould be thought on, at leaſt for ſuch whoſe preſent fortunes and future imployments, will not in any likelyhood require the knowledge of exotick Languages: To this purpoſe, it hath been my endeavour to effect two things for this Town of *Roſs*, namely to procure a competent maintenance for Gods

Miniſter

Miniſter there, that ſo the people may be inſtructed in the principles of religion and true piety; and ſome endowment for an Engliſh School, by which means the Children may be the eaſier taught what Religion is, as well as inſtructed in thoſe Arts and Sciences which will conduce to their more comfortable ſubſiſtance and preſent being.

The firſt of theſe, by Gods bleſſing, and the aſſiſtance of your (no leſs truly religious than) Honourable Grandfather is now effected to the Glory of God in all future ages; and had

it pleaſed God, to have ſpared him to us yet a little longer, his favourable countenance and aſſiſtance would not have been wanting in the other: very ſenſible he was that Arithmetick and Geometry are very neceſſary Arts for the common ſort of people to be inſtructed in, as well as for thoſe that act in a higher Sphear; and that they might be ſo, I have now compoſed this brief and plain Treatiſe of Arithmetick, in ſuch a Method, as will I hope prove uſeful even for Children of but ſeaven years of age, for their inſtruction in that Science; and as a thankful

thankful acknowledgement of the great kindneſs of your Honourable Grandfather to me (perſonally, but chiefly in aſſiſting me to bring in the Tithes of *Roſs*, *Brampton* and *Weſton* in this County of *Hereford* to the Church) I did intend to ſend this little treatiſe into the world in his name; but ſince Gods providence, (in removing him to a better place, and more laſting Honour) hath made my intentions fruſtrate, whither ſhould I go, or unto whom ſhould I addreſs my ſelf, but to you, who have ſucceeded him in his Honour and fortunes, and given

great hopes to the world of ſucceeding him in his vertues alſo; whoſe great bounty to the Clergy in the time of their ſequeſtration, to ſeveral Churches ſince his Majeſties happy reſtauration, not only in endowing them, with thoſe Tithes which the Law made his, and purchaſing others, but building convenient and beautiful habitations for the ſeveral Incumbents in thoſe places, his great charity to all in want, and care to put them into ſuch ways of living, as might make them comfortably to ſubſiſt (as his bounty in this particular to the City

of

of *Hereford* doth witneſs) ſeconded with his exemplary piety both in publick and private, will proclaim his worth, and make his name to be very precious in all ſucceeding generations.

And now what ſhall I ſay more, but for as much as the eyes of all men are upon you, and that you have ſucceeded this Honourable and much lamented Patriot of our Country, as *Eliſha* ſucceeded *Elijah*, I will only pray that a double portion of his ſpirit may be upon you, that the Glory of our Countrey may not together

with

with him depart from us, as it did from *Iſrael* when the Ark of the Lord was taken from them: God I hope will not only continue but augment your Glory, and the Glory of our Country, by making you to be inſtrumental for his: may your days be many, and your death Glorious; may it be with you as it was with *David* and your Honourable Grandfather, may you die in a good old Age, full of days, riches and honour, and your Son ſucceed you, ſo prayeth

Your Honours devoted ſervant,

JOHN NEWTON.

TO THE

READER,

I Have but lately under the Title of School paſtime preſented thee with the Rudiments of Grammar for our own tongue, as the firſt part of an Engliſh Academy; and loe here according to what was promiſed in that little book thou haſt the ſecond alſo, which is a ſhort treatiſe of Arithmetick; and for my thus doing two things may poſſibly be demanded of me, or objected againſt me: firſt, what need there was of any new Treatiſe of this kind, there being ſuch great

variety

variety thereof already: and ſecondly, why I place it next to Grammar, ſince the Liberal Sciences are uſually reckoned up in another order?

To which I anſwer, that among all thoſe Engliſh Treatiſes of Arithmetick, there is but one that I know of, or do at preſent remember, viz. *Mr.* Wingates, *in which the Rules of Arithmetick are propounded in any Logical Method; and methinks, it is very convenient, if not neceſſary, that the Rules in every Science ſhould be Methodically handled; and this I confeſs is ſo exactly well performed in that I but now mentioned, eſpecially in the ſecond Edition thereof, in the year* 1650, *that though by reaſon of the ſeveral Phantaſies of ſeveral men, ſomething may be altered, there is but little that can be amended; but the bulk and price is ſuch, that I fear but few parents will be willing to be at the charge of it, eſpecially for ſuch ſtriplings, as I would have inſtructed in this ſcience; for I know no reaſon, why a young Lad, that can but read his Pſalter, ſhould not be inſtructed in the Rudiments of Grammar, and the Art of Arithmetick; and whether this were not a likelier way, to*

teach

teach them to ſpell the words they hear, as well as thoſe they ſee, and ſo by conſequence, enable them to write truly as well as read diſtinctly, than by learning a Latine Grammar, I leave to thy judgment to determine. Were Children in their Infancy acquainted with the Art of numbering, there is nothing in that nature would be difficult to them in their riper years; and that they may be ſo, I have in this Treatiſe, at leaſt as I hope, very plainly as well as briefly and orderly ſet down the moſt uſeful rules of this neceſſary and moſt excellent Science; and would but our Engliſh Schoolmaſters put it to the tryal, I doubt not, but that the ſucceſs would anſwer all reaſonable expectations; for ſure there can be no reaſon given, why children in theſe ſhould not be as capable of this and other Mathematical learning, as in the days of Plato *and* Ariſtotle, *when all the Schools in* Greece *did teach Cihldren theſe things in the firſt place.*

And thus you have at once not only the reaſon, for which I have added this to thoſe many Treatiſes of this kind already publiſhed, viz. *that the memories of Children may not be over burthened with long directions and tedi-*

ous

ous diſcourſes, nor the purſes of Parents ſo over charged, as that the price of the thing ſhould be any bar to their childrens inſtruction; but alſo the reaſon for which I place this Science next to Grammar, even this, becauſe it is more ſuitable to Childrens capacities, than the other Sciences are, nay will be ſooner underſtood by them, than all the parts of Grammar can: nor ſhould the Art of Geometry be ſevered from Arithmetick, they are of ſo near a kin, that they ſhould indeed go hand in hand, and both of them together will make an excellent introduction to the other Sciences.

And becauſe that the writing of a good hand is as neceſſary as the other, and that it is almoſt as hard a matter to find a Maſter that is able to teach Youth the Art of fair writing (I mean in the Countrey) as of Arithmetick and Geometry, for the profit of Children, and the eaſe of Schoolmaſters, there is another little Book of Arithmetick, called, The Country Schoolmaſter, *which will be ſpeedily publiſhed alſo; in which the Titles of ſuch Rules of Arithmetick as children are firſt to learn, together with brief directions and examples, are engraved in a*

fair

fair uſeful writing hand, as will with the Maſters diligence be ſufficient for the teaching of children as well to write fairly, as to number readily; and becauſe a Child muſt firſt learn to write his letters well, before he be put to joyning, there is annexed thereto, a Copy of letters both great and ſmall, ſuteable to the other copies, of which thou mayeſt have as many as thou wilt alone; and upon very reaſonable terms: And if the Maſter have but ſo much Geometry, as to teach his children, to erect a perpendicular, and draw a parallel line, he ſhall never need to rule a book, or ſet a Copy, which will be a wonderful eaſe to him, and no leſs profit, and advantage to his Schollar; for which I pray is beſt, for the Schollar to rule his own book, or his Maſter to do it for him? which is better, for the Maſter to ſpend his time in writing of copies, or directing the child to write according to the Copy he hath? theſe two books then I would have Children furniſhed with as ſoon as they can but read their Pſalter, and hold a pen in their hands; the one to inform their judgements in the knowledge of the Rules in Arithmetick, and the other to teach them to write, and to put

their

knowledge of Arithmetick in practice; and as they shall profit in these things, so to be set forward in Geometry, and the other Sciences, for which, god willing, it shall not be long before I furnish thee with suitable Manuals to that purpose.

John Newton.

THE

THE ART OF Natural Arithmetick.

CHAP. I.

Of Notation.

1. ARITHMETICK, *is the Art of Accounting by Number.*

2. There are *three* kinds of it. 1. *Natural.* 2. *Symbolical.* 3. *Artificial.*

3. *Natural Arithmetick*, which is the subject of this present discourse, is either *Positive* or *Negative.*

4. *Positive Arithmetick*, is either *Single* or *Comparative.*

5. *Single is that, which is wrought by numbers considered alone, without relation to one another.*

6. *The parts of single Arithmetick* are *Notation* and *Numeration.*

7. *Notation is the writing down of any summs to*

be expressed, or the expressing of any summe set down in writing.

8. The *parts* of *Notation* are *two*; *The first doth explain the general value of the Notes, by which numbers are to be expressed.*

9. The *Notes* or *Characters by which Numbers* are *ordinarily expressed, are these*; 1. *one.* 2. *two.* 3. *three.* 4. *four.* 5. *five.* 6. *six.* 7. *seven.* 8. *eight.* 9. *nine.* 0. *nothing.*

10. These *Notes* are either *significant Figures* or *a Cypher.*

11. The *significant figures are the first nine*, viz. 1, 2, 3, 4, 5, 6, 7, 8, 9. and these have a certain signification when they are put by themselves, but any of these being joyned with it self or any of the rest doth become uncertain in it's signification; for every of these figures alone doth signifie it self once, but if two of them be set together, the first doth signifie it self once, the second doth signifie it self *ten* times, as in 22 the same figure which in the first place towards the right hand doth signifie only *two*, doth in the second place signifie *ten* times *two*, that is *twenty.*

12. *The Cypher doth indeed signifie nothing of it self, but being set before or after the rest, it doth increase or lessen their value.*

13. The *Value* of these *Notes is* more fully expressed by *Degrees* and *Periods.*

14. *The Degrees are three*; *The first, is the first place of a number towards the right hand*, and doth signifie it self once; *The second degree, is the second place towards the right hand*, and doth signifie it self *ten* times. *The third is the third place towards*

the

the right hand, and doth signifie one hundred times it self, so these figures 345 do signifie three hundred fourty five.

15. *A Period if it be perfect doth consist of three degrees, if imperfect it doth consist of fewer*: and it is either simple or compound. A simple period if it be perfect doth consist of three degrees; a compounded Period, may have all the Periods perfect, or the last towards the left hand may be imperfect. Thus 325 is a simple perfect period, and 325 678 is a perfect compound period, or a number consisting of two perfect periods; 23 is an imperfect simple period, and 23 456 is an imperfect compounded period.

16. The *second part of Notation, teacheth how to read a number that is expressed in writing.*

17. *Every number is either simple or mixt.*

18. *A simple number is that, whose parts are of one and the same kind, that is, either whole or broken.*

19. *A whole number is that, which doth consist of integers or entire unities*; thus 36 is composed of thirty six integers, or intire unities.

20. *Integers of one simple period, are to be read, as hath been shewed in the* 14 *Rule*: and integers which are composed of divers periods, are to be read much after the same manner, the periods being first distinguished from one another, by interposing a short stroke or point between each period, as, 15. 246. 368; whence 15 is an imperfect period, 246 and 368 are perfect periods. This or any other number thus distinguished into periods, may easily be read, by giving to every period its proper denomination.

21. The proper denomination of the first period is Hundreds. 2. Thousands. 3. Millions. 4 Thousands of Millions, & so forward increasing by a tenfold proportion as far as you please, but in ordinary practise, we seldom have occasion for the fourth period; the reading whereof will be best learned by young beginners, if they be first exercised in the reading of three or four figures, which being well understood the rest cannot be difficult; as by the Table following, if well considered, it will be manifest.

Thousands of Millions			Millions			Thousands			Hundreds		
C	X	I	C	X	I	C	X	I	C	X	I
											9
										9	8
									9	8	7
								9	8	7	6
							9	8	7	6	5
						9	8	7	6	5	4
					9	8	7	6	5	4	3
				9	8	7	6	5	4	3	2
			9	8	7	6	5	4	3	2	1
5	6	9	8	7	6	5	4	3	2	3	9

22. *According to this Table*, the fourth number 9.876 is thus to be expressed, Nine thousand, eight hundred, seventy six, and the last number 569.876.543.239. thus; Five hundred sixty nine Thousands of Millions, eight hundred seventy six Millions, five hundred forty three thousand, two hundred thirty nine, and so of any other.

CHAP.

CHAP. II.

Of Addition.

1. HItherto *we have treated of Notation, Numeration follows.*

Numeration is that which by certain known numbers propounded, discovereth another number unknown.

2. *Numeration hath four species, viz. Addition, Subtraction, Multiplication and Division.* In which besides the nine Figures and a Cypher, I shall for the avoiding of many words, make use of these Characters. (+) (−) (=) (x)

3. This Character (+) I use to represent these words *more by*, and is the signe of addition or affirmation; as 3 + 5 signifies 3 more by 5, or 5 added to 3, or the summe of 3 and 5 that is 8.

4. This Character (−) denotes the words *less by*, and is the sign of Subtraction or Negation; As 9 − 3 doth signifie 9 less by 3, or 3 Subtracted from 9, or the difference between 9 and 3 that is 6.

5. This Character (=) represents the words *equal to*, and is the note of an Æquation, so 6 + 3 = 9 are to be read thus, 6 more by 3 is equal to 9.

6. This Character (x) represents the words *multiplied by*, as 7 x 6 are thus to be read, 7 multiplied by 6, or the product of 7 and 6.

7. *Addition is that, by which divers numbers are*

added together, to the end that the ſumme or total may be diſcovered.

8. Numbers to be added are either ſimple, as 1. 2. 3. and the reſt which may be expreſſed with one note or figure; or elſe they are compounded, as 10. 11. 13. 234. which cannot be expreſſed without two or more figures.

9. The Addition of ſimple numbers is to be learned by practiſe rather than precept; as one added to one makes two, two and three make five and ſo of the reſt; this is ſo well known even to children, as that it needeth no further explication, but yet for Demonſtration ſake, and to prevent miſtakes in the adding of greater ſummes, I have here exhibited a ſhort Table declaring the ſum of all ſimple Numbers,

1	1	2	2	8	10	5	5	10
1	2	3	2	9	11	5	6	11
1	3	4	3	3	6	5	7	12
1	4	5	3	4	7	5	8	13
1	5	6	3	5	8	5	9	14
1	6	7	3	6	9	6	6	12
1	7	8	3	7	10	6	7	13
1	8	9	3	8	11	6	8	14
1	9	10	3	9	12	6	9	15
2	2	4	4	4	8	7	7	14
2	3	5	4	5	9	7	8	15
2	4	6	4	6	10	7	9	16
2	5	7	4	7	11	8	8	16
2	6	8	4	8	12	8	9	17
2	7	9	4	9	13	9	9	18

This

This Table doth consist of two columns, in the first are the two simple numbers to be added, and in the second, the summe or total of those numbers, as if 5 and 7 were to be added, right against 5 and 7 in the first columne, I find 12 in the second column for the summe of them.

4. The Addition of compositе numbers is something more difficult, and yet it doth depend upon the addition of simple numbers. But that this may be the more commodiously done, the numbers to be added must be so set down, that the unites may stand under the unites, the tens under the tens, and the hundreds under the hundreds, &c. as if the numbers 52364 + 36512 were given to be added, you are to place them as in the Margin.

5	2364
3	6512
8	8876

5. Having thus placed the numbers draw a line under them, and then adde them together, beginning with the unites first, saying $2+4=6$ which I subscribe in the place of unites under the line, and $1+6=7$ which I subscribe in the place of tens, $5+3=8$ which I subscribe in the place of hundreds, and so $6+2=8$ and $3+5=8$ which being subscribed in their respective places, the total summe is 88. 876.

6. But it frequently happens that the several summes of the particular ranks are too great to be expressed with one figure, when this happens write down the first figure of the summe in it's own proper place, and the other figure in the next place above it, and so in the next rank as oft as need shall require, as in the example following.

In which the ſumme of the figures in the unites place is 25, therefore writing down 5 in the place of unites, and the figure two which may be ſaid to ſignifie 20 or two decades, I ſet in the next place above it, that is in the place of tens.

789256
493587
364728
631254
211225
206760
2278825

In like manner the ſumme of the decades is 20, and therefore writing 0 in the rank of tens, the 2 which ſignifies 20 decades or 200 I ſet in the place of hundreds, and ſo the reſt in their order; and adding the two laſt ranks together, the total ſumme is 2.278.825.

7. But this work which for plainneſs ſake is thus ſet down, may be more briefly performed, if beginning with unites, the laſt figure of the ſumme be only ſet down, and the other kept in mind, and numbered in the next rank, in this manner, becauſe in the rank of unites 8 + 9 = 17. 17 + 6 = 23. 23 + 7 = 30. 30 + 4 = 34, ſubſcribing 4, the other 3 being kept in memory, I preſently adde to the next rank thus, 3 + 3 = 6. 6 + 8 14. 14 + 1 = 15. 15 + 6 = 21. 21 + 5 = 26, ſubſcribing 6 I carry 2 to the next rank, ſaying,

472638
513789
856416
789567
634754
3267164
2794526
3267164

2 + 6 = 8. 8 + 7 = 15. 15 + 4 = 19. 19 + 5 = 24. 24 + 7 = 31 ſubſcribing 1 I carry 3 to the next rank 3 + 2 = 5. 5 + 3 = 8. 8 + 6 = 14. 14 + 9 = 23. and 23 + 4 = 27 ſubſcribing 7 I carry

carry to the next rank, saying, 2 + 7 = 9. 9 + 1 = 10. 10 + 5 = 15. 15 + 8 = 23. 23 + 3 = 26 subscribing 6 I carry 2 to the next rank, saying, 2 + 4 = 6. 6 + 5 = 11. 11 + 8 = 19. 19 + 7 = 26. 26 + 6 = 32 subscribing 2, the other 3 I set in the next rank, because there is nothing more to be added, and so the total summe is, 3267163.

The proof of Addition is thus, draw a line under the first rank of numbers, then adde together all the remaining ranks, as hath been shewed; Lastly, to that total adde the first rank of numbers: if that be the same with the first total found, the Addition is true, otherwise not.

As in the last example, the first rank of numbers is, 472638, and the total of the other four ranks, is, 2794526, to which the first rank being added, the total will be 3267164, as may be before found, therefore the first rank was true. The like may be done in any other.

CHAP.

CHAP. III.

Of Subtraction.

1. SUBTRACTION is that, by which one number is taken out of another which is greater or at leaſt equal to the former, that the reſidue or remainer may be known.

2. The Subtraction of ſimple numbers is ſo eaſie, that every one is ſuppoſed to know that, either naturally or by daily practiſe; but if this alſo ſhall in any caſe be thought neceſſary, it may be readily performed by the former table, as if 2 were to be Subtracted out of 9, looking in the former table for 2 in the firſt column, and 9 in the ſecond, the number between them is 7 which is the remainer ſought.

3. But where one compoſite number is to be Subtracted from another or a ſimple number from a compoſite, the two numbers given muſt be written one under another, the leſſer under the greater, as was directed in Addition, that is, the unites under the unites, and the tens under the tens, &c. So the numbers 678945 and 543214 being given to be ſubtracted the one out of the other, they muſt be placed as in the Margin; then proceeding to the ſubtraction, I ſay $5-4=1$ which I place in the ſame rank under the line; In like manner $4-1=3$ which I likewiſe ſet under the line in the next rank, and thus finiſhing the

678945
543214
135731

the whole operation, the remainer of 678945 − 543214 is 135731. As in the Example.

4. When any of the figures of the number given to be ſubtracted is greater than the figure, out of which it is to be ſubtracted, you muſt borrow one of the next rank towards the left hand, and then the figure of which they are ſo borrowed muſt afterwards be eſteemed an unite leſs, or, which is all one, the figure to be ſubtracted from it, muſt be ſuppoſed an unite greater, and the one which is borrowed may if you pleaſe for memory ſake be ſet between two little lines.

So the numbers 730582 and 51368 being given to be ſubtracted, the laſt from the former and placed as before; I am to deduct 8 out of 2 which cannot be, borrowing therefore one decade from the following figure, (which is equal to 10 unites) the 2 is made 12 and 12 − 8 = 4 which I ſet down under the unites, and the one which I borrowed under the tenths between the lines. And then, ſaying, 1 + 6 = 7 and 8 − 7 = 1 which I ſet down in the place of tens; and then 5 − 3 = 2 which I ſet in the place of hundreds, and then 1 out of 0 I cannot but borrowing one from the next rank 10 − 1 = 9 which I ſet in the place of thouſands, and the 1 which I borrowed under the next rank between the lines, and then, ſaying, 1 + 5 = 6, but 6 from 3 I cannot, therefore borrowing 1 as before, it is 10 + 3 = 13, & 13 − 6 = 7; laſtly 7 − 1 (which was borrowed) = 6 and ſo the remainer is 679214 = 730582 − 51368.

730582
51368
67921
4

CHAP.

CHAP. IV.

Of Multiplication.

1. MULTIPLICATION, is that by which we multiply two numbers, by one another, that their product may be discovered.

2. Multiplication hath three parts, the Multiplicand, the Multiplicator and the Product.

3. The Multiplicand is the number given to be multiplied. The Multiplicator is the number by which the Multiplicand is multiplied; and the Product is the number produced by the Multiplication: So if 7 be given to be multipled by 4, the third number which is produced is 28, for 4 times 7 is 28; and here 7 is the Multiplicand, 4 the Multiplicator, and 28 the Product.

4. Multiplication is single or compound.

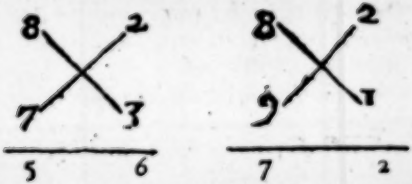
5. Single Multiplication, is when the Multiplicand and Multiplicator do each consist of single figures, and this is either to be performed by memory, or to be performed by many additions, till use and practise hath made it familiar; but for a help to memory in this particular, the Multiplication of simple numbers may be conceived by this Theoreme.

6. If one of the two numbers given shall be divided into as many parts as you please, the Product of both numbers, shall be equal to all the Products made by one of the numbers and all the parts of the other. As for the small numbers, as how

how much 2 times 4, 4 times 5, or 3 times 6, even nature it ſelf doth teach unto children. But if thou be not ſo ready in the greater notes, thou mayeſt by this means make it familiar. As if the Product of 7 times 8 were required, divide one of them into what parts you pleaſe, as 7 into 2. 3. 2. if 8 be multiplied by theſe parts, the ſumme of the ſeveral products will be 56. And ſo for 8 times 9 divide 9 into 3.3.3. and multiply 8 by theſe parts, the ſumme of the products ſhall be 72: and ſo of any other.

8		8		9	
2 3 2	7	3 3 3	9	4 4	8
16		24		36	
24		24		36	
16		24			
56		72		72	

7. The memory may be alſo helped in the multiplication of ſimple numbers in this manner. If two numbers be propounded, which together are more than 10, if you multiply both their differences from 10, and alſo deduct either difference from the other number, the product and remainer ſet in diverſe degrees, ſhall be the product of the given numbers. As in theſe Examples.



By either of these ways the product of single figures may be attained, but for the greater ease of young beginers, we have also added this table, in which the product of all the single figures is expreſt; the numbers to be multiplied are set in the first column, and the product in the second, as 7 and 8 being given, right against those numbers is 56 which is the product of them.

The Multiplication Table.

2.2	4
2.3	6
2.4	8
2.5	10
2.6	12
2.7	14
2.8	16
2.9	18
3.3	9
3.4	12
3.5	15
3.6	18

3.7	21
3.8	24
3.9	27
4.4	16
4.5	20
4.6	24
4.7	28
4.8	32
4.9	36
5.5	25
5.6	30
5.7	35

5.8	40
5.9	45
6.6	36
6.7	42
6.8	48
6.9	54
7.7	49
7.8	56
7.9	63
8.8	64
8.9	72
9.9	81

8. The Multiplication of ſingle figures being thus attained, the Multiplication of compounded numbers cannot be difficult.

9. In Compound Multiplication, ſet down the given numbers, as in Addition and Subtraction: ſo 3421 being given to be multiplied by 2, place 2 the Multiplicator under 3421 the Multiplicand, and having drawn a line, write the double of every figure in the Multiplicand under the line (becauſe the Multiplicator is 2,) in the ſame degree always with that figure of which it is the double. Thus the double of one is 2, the double of 2 is 4, the double of 4 in the place of hundreds is 8, & the double of 3 in the place of thouſands is 6 and the product of 3421 multiplied by 2 is 6842.

3421
2
6842

10. When the product of any of the particular figures exceeds ten, place the exceſs under the line as before, and the laſt figure in the next place to it, but a line lower, and ſo the reſt until the multiplication be finiſhed; as if the ſame number 3421 were to be multiplied by 8. every figure of the multiplicand is to be made 8 times as much as it is, and ſubſcribed in their proper places, and then to be collected into one ſumme. Thus 8 times 1 is 8, which I place under the 1. and 8 times 2 is 16, I write 6 in the place of tens a line lower, and 1 in the upper line, in the place of hundreds, 8 times 4 is 32, I write 2 in the lower line in the place of hundreds, and 3 in the upper line a place forwarder, that is in the place of thouſands, 8 times 3 is 24 thouſands, I write 4 therefore in the place of thou-

thouſands in the lower line, and 2 a place forwarder, in the upper or the lower line it matters not which, becauſe it is the laſt figure in the product. And theſe two lines of numbers being added together, the ſumme is, 27368 = 3421 x 8.

3421
8
3108
2426

11. But this may be more compendiouſly performed, if that every figure to be ſet in the upper line ſhall be committed to memory and added to the next rank. So 3421 being given to be multiplied by 8 as before: for 8 times 1 I write 8 under the line in the place of unites: for 8 times 2 being 16 I write 6 under the line in the place of tens, and reſerve 1 for the ten it exceeds to be added in the next rank, the place of hundreds. Then I ſay 8 times 4 is 32, unto which if I adde 1 which I kept in mind the whole is 33, wherefore ſubſcribing 3 in the next rank under the line in the place of hundreds, and carrying 3 in mind for the three tens that it exceeds, I proceed to perform the reſt of the work, as you ſee it in the Example.

3421
8
27368

12. When the Multiplicand and the Multiplicator are both compounded numbers; for ſo many figures as are in the Multiplicator, ſo many ſeveral products muſt be ſubſcribed under the line which at laſt being added into one ſumme gives you the total product of all: ſo 3421 being given to be multiplied by 28, the operation will ſtand thus.

For

For 3421 being multiplied by 8 the product is 27368: again 3421 being multiplied by 2 the product is 6842, which several products standing in their due order and added together do make 95788 the product required.

```
3421
  28
-----
27368
68 42
-----
95788
```

13. When in the Multiplicator there are Cyphers between the significant figures, you must multiply by the significant figures only, neglecting the Cyphers, and set each particular product in its due place, according to what hath been said in the last rule, and as is done in these examples following.

```
  634
  203
-------
 1902
1268
128702
```

```
 2361
20104
-------
 9444
2361
4722
-------
47465544
```

14. When the numbers given to be multiplied do one or both of them end with Cyphers, neglecting the Cyhers, multiply by the significant figures only, and having added together the several products according to the former directions, annex as many Cyphers to the summe of all the products, as were at the end of both the numbers given, so shall you have the product desired as in the examples following.

3674	476300
230	38400
11022	19052
7348	38104
845020	14289
	18289920000

15. When one of the Numbers given is an unite with nothing but Cyphers annexed, the Multiplication is performed by annexing so many Cyphers to the Multiplicand, as there are in the Multiplicator; so if 4327 were to be multiplied by 1000, the product will be 4327000.

CHAP.

CHAP. V.

Of Diviſion.

1. DIVISION is that, by which we diſcover how often one Number is conteined in another, and thereby find the Quotient of the greater Number.

2. Diviſion hath three parts, the Dividend, the Diviſor and the Quotient. The Dividend is the Number given to be divided; The Diviſor is the Number by which the Dividend is divided; and the Quotient is the Number which the Diviſion doth produce: So if 18 were given to be divided by 3, the Number produced would be 6, for 3 is found 6 times in 18, and here 18 is the Dividend, 3 the Diviſor, and 6 the Quotient.

3. Diviſion is either ſingle or compound. When the Diviſor is a ſingle figure, and the Dividend leſs than 10 the anſwer may be given by memory; or if the Dividend be the product of two ſingle figures, the anſwer may be had from the multiplication table if need be; for finding the Diviſor in the firſt Column and the Dividend in the ſecond, the other figure in the firſt Column is the Quotient ſought; as if 56 were to be divided by 7, in the ſame line where I find 7 in the firſt Column, and 56 in the ſecond, I find 8 alſo, which is the Quotient.

4. When the Diviſor is a ſingle figure, and the Dividend a Number of many places, make a

crooked line at each end of the Dividend, that on the left hand ſerving for the place of the diviſor, & that on the right, for the Quotient; then proceed gradually, & aſk how often the diviſor is contained in the Dividend, and place that which anſwers the queſtion in the Quotient, then multiply the Diviſor by that figure in the Quotient, & ſubſtract the product from the dividend, ſetting down the remainer. For example, let 2916 be given to be divided by 4. placing the numbers as hath been ſaid; I aſk how often 4 is conteined in 29, the anſwere is 7 times I therefore put 7 in the Quotient, then I multiply 4 by 7 and it makes 28 which being ſubtracted from 29 the remainer is 1. Then drawing a ſtroke between the remainer and the Dividend, I draw down the next figure which is 1 alſo, and ſo the new Dividend is 11, then I aſk how often 4 is conteined in 11, the anſwer is twice, therefore I put 2 in the Quotient, and 4 multiplied by 2 makes 8 which being deducted from 11 the remainer is 3 which I write under 11 and draw a ſtroak between them as before, and draw down the next figure which is 6, and ſo the new divided is 36. Then I aſk how often 4 is conteined in 36 the anſwer is 9 times, therefore I place 9 in the Quotient, and 4 multiplied by 9 the product is 36, which being deducted from 36 the remainer is 0; and therefore the diviſion is finiſhed and the Quotient required, is 729.

```
4 ) 2916 ( 729
    11
    --
     36
     --
     00
```

5. When

5. When the Divisor is also a composite Number, though the work be somewhat more troublesome, yet is the manner of working the same with the former; & therefore the former example well considered, will make way for that which follows. Let then 6639642 be a Number given to be divided by 978, and being set down as is before directed, distinguish by a point so many of the foremost places of the Dividend towards the left hand as are either equal to the Divisor, or being greater do yet come nearest to it,

which in this Example must be under 9 for 6639 is the least number in this Dividend, from whence 978 can be subtracted. Now therefore I demand how often 978 is conteined in 6639, and since to answer this and the like question some trial must be made, write the Divisor in a place by it self, and the product thereof by all the nine figures in this manner.

978)6639642(

First, write down the Divisor it self 978 and draw a line on the right hand thereof, and on the right hand of the line right against the Divisor write 1. then underneath the divisor write the double thereof which is 1956, and right against the said double on the other side of the line under 1. write 2. Then adde the Divisor 978 to 1956 the double thereof and their summe 2934, is the triple of the Divisor, which must be placed under the double, and 3 right against on the other side of the line; then adde the Divisor 978 to 2934 their summe 3912 must be put under the triple, and so proceed till you have nine ranks of num-

bers shewing the product of your divisor by all the 9 figures, and to prove your work, adde the ninth and last number to the first, so will their summe be ten times the Divisor, if the work be true, thus 978 + 8802 = 9780.

A Table exhibiting the several products of your Divisor by all the 9 digits being thus prepared; an answer to the former question may be easily found, for in that table you may see that the neareſt less to 6639 is 5868 and the figure right against it on the other side the line is 6, therefore I place 6 in the quotient and the product of 978 by 6, that is 5868 I write under 6639 and subtract the said product from it, so is the

978	1
1956	2
2934	3
3912	4
4890	5
5868	6
6846	7
7824	8
8802	9

6639 642(6789
5868
7716
6846
8704
7824
8802
8802
0

remainer 771. Then deducting 6846 = 978 x 7 from 7716, and 7824 = 978 x 8 from 8704 and 8802 = 978 x 9 from 8802 the Quotient will be 6789, and the remainer nothing.

This method being practised a while, you may at length shorten the work of the table in this manner. Having doubled the Divisor, as before, and so

ſo got the product thereof by 2, double that double, ſo ſhall you have the product by 4, and the product of 4 being doubled will give you the product by 8, and then the table will be as here you ſee it; from whence all the other products may be eaſily had; for the firſt and ſecond is 29 34 the product by 3, and 1956 + 3912 = 5868 the product by 6, the ſumme of the firſt and third is 4890 the product by 5, the ſumme of the firſt ſecond and third is 6846 the product by 7, the firſt and fourth is 8802 the product by 9, and by uſing this contraction but a while, you will at laſt be able to divide any ſumme without the help of any ſuch table, and uſe as few figures as in any other method that I yet know to be made publike.

978	1
1956	2
3912	4
7824	8

6. When the Diviſor hath one or more Cyphers after the ſignificant figures, the work is to be performed by the ſignificant figures only, cutting off ſo many figures from the Dividend as there are Cyphers at the end of the Diviſor, and after the diviſion is finiſhed annex the figures ſo cut off to the remainer of the Dividend.

7. When the Diviſor is an unite with Cyphers, the Diviſion is performed by cutting off with a line ſo many figures of the Dividend towards the right hand, as there are Cyphers in the Diviſor, the reſt of the figures in the Dividend towards the left hand is the Quotient ſought.

CHAP. VI.

Of the Notation of Fractions.

1. THe ſame parts of Arithmetick which have been wrought in whole numbers may alſo be performed in broken numbers, otherwiſe called parts or fractions, but firſt it will be neceſſary to ſhew what is meant or intended by the word fraction or fractions, and then proceed to their Notation and Numeration.

2. Fractions or broken numbers, are not ſo properly called numbers as fragments of unitie, for although an unite is the leaſt number, yet this one may be ſuppoſed to be divided, ſometimes into more ſometimes into fewer equal parts as the thing ſhall require.

3. And as the equal parts of an unite may be ſometimes more, ſometimes fewer, ſo have thoſe parts ſometimes one Denomination ſometimes another; ſo that if an unite be ſuppoſed to be divided into two equal parts, one of thoſe parts is called half, if into 3, one of thoſe parts is called a third, if into 4, a fourth, if into ſix a ſixth, if into eight, an eighth, if into ten, a tenth, and ſo of others. And in writing of fractions, this Denomination is expreſſed, by writing ſuch a figure under a little line as is proper to them. And the number of parts ſuppoſed to be taken are expreſſed by another figure above the line, thus a 2 above the line and a 3 under it do expreſs two thirds. A 3 ſet above the line and a 4 under it, do expreſs three fourths, and ſo of any other.

4. A

4. A fraction then is to be written with two numbers, of which the lowermoſt is called the Denominator, becauſe it doth denominate the parts, and limits or determines how many parts are to be numbred; and the upper number, is called the Numerator, becauſe this doth number the parts, or ſhew how many of thoſe parts are to be taken.

5. A number of parts then being propounded to be ſet down in writing, as the one half of a yard, or three fourths of a foot, they are to be written thus $\frac{1}{2}$ $\frac{3}{4}$ in which 1. 3. are the numerators, and 2. 4. the denominators.

6. A broken number is either proper or improper.

7. A proper broken number, is that, whoſe numerator is leſs than the Denominator: ſuch as are theſe $\frac{3}{4}$ $\frac{6}{12}$ $\frac{5}{10}$.

8. A proper broken number is either ſingle or compound.

9. A ſingle broken number is that which conſiſts of one numerator, and one Denominator: ſuch as are $\frac{3}{4}$ $\frac{6}{12}$ $\frac{5}{10}$ and the like.

10. A compound broken number (otherwiſe called a fraction of a fraction) is that which hath more numerators and more Denominators than one, which kind of broken numbers are commonly ſet down with the particle *of* between them, as five twelfths of one third is to be written thus $\frac{5}{12}$ of $\frac{1}{3}$, three fourths of ſeven eighths thus $\frac{3}{4}$ of $\frac{7}{8}$ and ſo of any other.

11. The things to be expreſſed by broken numbers are chiefly the parts or fractions of money, weight, meaſure, time, motion, and things accounted by the Dozen. Of the three firſt of theſe

theſe there are infinite kinds and varieties according to the Laws and Cuſtoms of particular Countries; thoſe uſed in this kingdom are moſt proper for us to know, and the knowledge of them will be ſufficient to direct us in the uſe of thoſe in forreign nations, if at any time there be an occaſion for them.

12. The ſeveral pieces of Coine or Denominations of money uſed in *England* in reference to account, are pounds, ſhillings, pence and farthings, whoſe particular values are as followeth.

4. Farthings 12. Pence 20. Shillings	make	1. Penny. 1. Shilling. 1. pound *Sterling*.

And according to theſe values, a pound *Sterling* is eſteemed an integer, and may be divided into 20 parts called ſhillings, and therefore one ſhilling is a broken number of a pound *Sterling*, & by the former directions is to be written thus $\frac{1}{20}$ l. that is one twentieth of a pound. Again a ſhilling may be divided into twelve equal parts called pence, and ſo one penny is a fraction of a ſhilling, and is to be written thus $\frac{1}{12}$ s. that is one twelfth of a ſhilling. Laſtly, a penny may be divided into four equal parts called farthings, and ſo one farthing is a fraction of a penny, and written thus $\frac{1}{4}$ d. that is one fourth of a penny, or thus $\frac{1}{4}$ of $\frac{1}{12}$ s. that is one fourth of one twelfth of a ſhilling, or thus $\frac{1}{4}$ of $\frac{1}{12}$ of $\frac{1}{20}$ l. that is one fourth of one twelfth of one twentieth of a pound *Sterling*.

13. Now then though the true and natural way

way of expreſſing broken numbers is by their Numerators and Denominators, as hath been ſhewed, yet the broken numbers or known parts of money, weights, meaſures and ſuch like, are for more convenient operation, commonly expreſſed like integers: ſo that if 12 ſhillings ſeven pence half peny farthing were to be expreſſed in figures, the ordinary & moſt uſual way is thus, 12s-07d, 03f. but the ſaid twelve ſhillings ſeven pence half peny farthing, being diſtinctly conſidered as fractions of a pound *Sterling*, the way to write them properly is thus,

12 Shillings, are twelve twentieths of a pound *Sterling*, and written thus, $\frac{12}{20}$ l.

7 Pence are ſeven twelfths of one twentieth of a pound *Sterling*, and written thus $\frac{7}{12}$ of $\frac{1}{20}$ l.

3 Farthings are three fourths of one twelfth of one twentieth of a pound and written thus $\frac{3}{4}$ of $\frac{1}{12}$ of $\frac{1}{20}$ l.

14. The weights uſed in *England* are of two ſorts, *Troy* weight and *Averdupois*.

15. The ſeveral pieces or Denominations of *Troy* weight, are pounds, ounces, peny weights and grains, whoſe particular values are as followeth.

24 Grains		1 Peny weight.
20 Peny weight	make	1 Ounce
12 Ounces		1 Pound *Troy*.

16. The weights uſed by Apothecaries are derived from a pound *Troy*, the which is ſubdivided as in the following Table.

℔ A pound Troy	} is equal to	}	12 Ounces.
℥ An Ounce			8 Drams.
ʒ A Dram			3 Scruples.
℈ A Scruple			20 Grains.

17. But beſides *Troy* weight, there is another kind of weight uſed in *England* call'd *Averdupois* weight, a pound whereof is equal unto 14 ounces, and twelve-peny weight *Troy*.

18. This *Averdupois* weight is either great or ſmall.

19. The great *Averdupois* weight is, when an hundred conſiſting of 112 pounds *Averdupois* is the integer, and ſubdivided into halves and quarters, each quarter conteining 28 pounds.

20. The ſmall *Averdupois* weight is, when a pound is the integer, each pound being ſubdivided into 16 ounces, each ounce into 16 drams and each dram into 4 quarters, and becauſe many perſons have occaſion to uſe both, and are perhaps furniſhed but with one, I have here exhibited a Table for the ſpeedy converting of the parts of a pound *Troy*, into the parts of a pound *Averdupois*, and the Contrary.

Drams

Drams *Averdupois*.		Peny-weights *Troy*.	Grains.	Decimals of a grain.		Ounces *Averdupois*.	Ounces *Troy*.	Peny-weights.	Grains.
1		01	03	375	1	1	00	18	06
2		2	06	750		2	01	16	12
3		3	10	125		3	2	14	18
4	Dram	4	13	500		4	3	13	
5	*Aver-*	5	16	875		5	4	11	06
6	*dupois*	6	20	250		6	5	9	12
7		7	23	625		7	6	7	18
8	weight	9	03	000		8	7	06	
9	is equal	10	06	375		9	8	04	06
10	to.	11	19	750		10	9	02	12
11		12	03	125		11	10	00	18
12		13	16	500		12	10	19	00
13		14	19	875		13	11	17	06
14		15	23	250		14	12	15	12
15		17	02	625		15	13	13	18
16		18	06	000		16	14	12	00

21. The measures used in *England* are of two sorts, Capacity or Length.

22. The measures of Capacity are produced from weight, and are also of two sorts liquid or dry.

23. The liquid measures are those, in which all kind of liquid substances are measured, and are expressed in the table following.

1. Pound

1 Pound of wheat *Troy* weight	make	1 Pint.
2 Pints		1 Quart.
2 Quarts		1 Pottle
2 Pottles		1 Gallon.
8 Gallons		1 Firkin of Ale, Sope, Herring.
9 Gallons		1 Firkin of Beer.
10 $\frac{1}{2}$ Gallons		1 Firking of Salmon or Eels.
2 Firkins		1 Kilderkin.
2 Kilderkins		1 Barrel.
42 Gallons		1 Tierce of Wine.
63 Gallons		1 Hogſhead.
2 Hogſheads		1 Pipe or But.
2 Pipes or Buts		1 Tau of wine.

24. Dry meaſures are thoſe in which all kind of dry ſubſtances are meaſured, as grain, Sea-coal, Salt and ſuch like, and are expreſſed in the table following.

1 Pint	make	1 Pint.
2 Pints		1 Quart.
2 Quarts		1 Pottle.
2 Pottles		1 Gallon.
2 Gallons		1 Peck.
4 Pecks		1 Buſhel land meaſure.
5 Pecks		1 Buſhel water meaſure.
8 Buſhels		1 Quarter.
4 Quarters		1 Chalder.
5 Quarters		1 Wey.

25. Long

25. Long measures are as followeth.

3 Barley Corns in length	make	1 Inch.
12 Inches		1 Foot.
3 Foot		1 Yard.
3 Foot 9 Inches		1 Ell.
6 Foot		1 Fathom.
5 Yards and ½		1 Pole or Perch.
40 Poles		1 Furlong.
8 Furlongs		1 *English* Mile.

26. In superficial or square measure 40 square poles or perches make 1 Rood or quarter of an Acre, and 4 Roods an Acre.

27. A Table of Time, is this that followeth.

1 Minute	make	1 Minute.
60 Minutes		1 Hour.
24 Hours		1 Day.
7 Days		1 Week.
4 Weeks		1 Moneth of 28 Dayes.
13 Moneths 1 Day and 6 hours		1 Year, not exactly, but very near.

28. A year is that space of time in which the Sun doth finish course through the circle in the heavens called the Zodiack, which is in 365 days, 5 hours, 4 min.

29. The

29. The Zodiack by is Astronomers divided, or supposed to be, into twelve equal parts called *Signs*, whose names and Characters are these, *Aries*, ♈. *Taurus*, ♉. *Gemini*, ♊. *Cancer*, ♋. *Leo*, ♌. *Virgo*, ♍. *Libra*, ♎. *Scorpio*, ♏. *Sagittarius*, ♐. *Capricornus*, ♑. *Aquarius*, ♒. *Pisces*, ♓. And each of these *Signs* into 30 parts called Degrees, so that this and all other Circles are supposed to be divided into 12 times 30 parts or Degrees, that is into 360, each degree into 60 minutes, each minute into 60 seconds, each second into 60 thirds, &c.

30. Of things accounted by the Dozen, A gross is the Integer consisting of 12 dozen, and each dozen of twelve particulars,

31. An improper fraction or broken number is that, whose numeration is greater than the Denominator. As $\frac{54}{12}$ feet, that is, fifty and four twelfths of a foot; and this may be well called an improper fraction, seeing it will not admit of the definition of a true broken number, because it is greater than that whole, whereas a fraction is properly but a part of the whole.

32. A mixt number, is that, which besides the integers or intire unities of which it consists, hath also a broken number annexed: As in this improper fraction $\frac{54}{12}$ if you divide the numerator 54 by the denominator 12 it will be reduced into the mixt number $4\frac{6}{12}$ of which 4 is the whole part, and $\frac{6}{12}$ the broken number or fraction.

33. And this I hope is sufficient to shew what is meant by a fraction, and how all fractions whether proper or improper, are to be expressed and

and read, which is the Notation of them; the next thing propounded concerning fractions is their Numeration, whether such fractions be expressed by their true and natural way, that is by their Numerators and Denominators, or whether they be expressed like integers, as the known parts of money are expressed by pounds, shillings, pence and farthings, and the known parts of *Troy* weight by pounds, ounces, pennyweights and grains; of these and the like broken numbers which are expressed like integers we speak of first.

CHAP. VII.

Of the Numeration of such broken numbers as are expressed like integers.

1. Numeration of such as are expressed like integers, is twofold.
2. Accidental and Essential.
3. Accidental Numeration is otherwise called Reduction.
4. Reduction is either descending or ascending.
5. Reduction descending is when a number of a greater Denomination being given, it is required to find how many of a lesser Denomination are equal in value to that given number of the greater: as when it is required to find how many shillings are containedin 34 pounds; or how many

pence in 325 ſhillings, or how many hours in 365 daies.

6. Reduction deſcending is performed by Multiplication, for if the given number of integers of a greater denomination, be multiplied by the number of integers, contained in the next inferiour denomination, the product ſhall ſhew how many of that inferiour denomination, are contained in the integers of the greater denomination given; for example, let 34 pounds be the greater denomination given, and let it be required to ſhew how many ſhillings are in 34 pounds, ſhillings being the next inferiour denomination unto pounds, and that every pound doth contein 20 ſhillings, as hath been ſhewed, if you multiply 34 by 20 the product is 680; the number of ſhillings required. In like manner 680 ſhillings will be reduced into 8160 pence, if you multiply 680 by 12 the number of pence in a ſhilling; and 8160 pence will be reduced into farthings 32640, if you multiply 8160 by 4 the number of farthings in a penny.

34	pounds
20	
680	ſhillings
12	
1360	
680	
8160	pence
4	
32640	farthings

The like method is to be obſerved in weights and meaſures or any thing elſe that is or may be ſubdivided, into inferiour denominations; thus,

26 pound

26 pound *Troy* will be reduced into 312 ounces, and 312 ounces into 6240 penny weights, and 6240 penny weights into 149760 grains, as by the operation in the margin it doth appear.

```
  26 pound
  12
 ----
  52
  26
 ----
 312 ounces
  20
 ----
6240 p.w.
  24
 ----
 24960
 12480
 ----
149760 Gr.
```

And in this manner may any number of a greater denomination given, be reduced into the least denomination, into which the greater is supposed to be subdivided.

Reduction ascending is, when a number of a lesser denomination being given, it is required to find how many of a greater denomination are equal in value to that given number of the lesser; as when it is required to find how many pence are contained 32640 farthings, or how many shillings in 8160 pence, or how many daies in 8760 hours.

And this kind of Reduction, called Reduction ascending, is performed by Division; for if the number of integers given be divided by the number of integers in the next superiour or greater denomination, the quotient shall be the number of integers sought; so 32640 farthings being divided by 4, the number of farthings in a penny,

the quotient is 8160 the number of pence conteined in 32640 farthings: In like manner if 8160 pence be divided by 12

```
                 12      20
4)32640   (8160   (680   (34
  32        72
  ---       ---
    6        96
    4        96
  ---       ---
   24        00
   24
  ---
    0
```

the number of pence in a ſhilling, the quotient will be 680, the number of ſhillings in 8160 pence; and laſtly, if 680 ſhillings be divided by 20 the number of ſhillings in a pound, the quotient will be 34, the number of pounds in 680 ſhillings; the like may be done by any other integers of any known denomination given.

CHAP.

CHAP. VIII.

Of the Addition of numbers that are of diverſe Denominations.

1. ACcidental Numeration of ſuch broken numbers as are expreſſed like integers, hath been ſhewed; that which is eſſential now followeth.

2. Eſſential Numeration doth conſiſt of Addition, Subduction, Multiplication and Diviſion.

3. When the numbers propounded to be added are of diverſe denominations, you muſt begin with the leaſt denomination firſt, and ſet down their ſum under that inferiour denomination, if their ſum be fewer than the number of parts in the next greater denomination; but if their ſum be more than the number of parts in the next greater denomination, ſet down the exceſs; if equal ſet down a Cypher, and the reſt muſt be added to the next ſuperiour denomination, and for memory ſake it may be ſet down under that denomination to which it is to be added; as in the example following.

In which I begin with the farthings first, and say 3 + 2 = 5 that is one penny and a farthing, wherefore setting 1 down under the denomination of farthings I carry a penny to the denomination of pence, and say 1 + 7 = 8, and 8 + 4 = 12, and 12 + 5 = 17 pence, that is 1 shilling and 5 pence, wherefore I set down 5 in the lowest rank under the denomination of pence and 1 in the line above it under the denomination of shillings, and say 1 + 8 = 9, and 9 + 19 = 28, and 28 + 13 = 41, that is 2 pounds 1 shilling, wherefore I set 1 in the lowest line under the denomination of shillings and 2 in the line above under the denomination of pounds, and say 2 + 16 = 18, and 18 + 7 = 25, and 25 + 24 = 49, which being set down in the lower line under the denomination of pounds, the total of the three sums propounded is 49 pounds 1 shilling 5 pence and 1 farthing.

l	s	d	f
24	13	05	3
07	19	04	0
16	08	07	2
2	1	1	
49	1	5	1

More examples of this rule are these following.

Troy

Troy Weight.

lib.	oun.	p.w.	Gr.
23	10	17	19
15	111	08	03
09	07	18	23
04	03	13	12
21	09	18	05
75	07	19	14
51	08	18	19
75	07	16	14

Motion

ſig.	deg.	min.	ſec.
11	23	45	16
11	15	55	42
9	03	37	28
10	17	24	36
8	29	59	47
7	12	28	33
11	13	11	22
11	19	26	06
11	13	11	22

Averdupois.

lib.	oun.	dr.	f.
15	13	12	02
23	11	14	03
10	15	07	01
12	08	15	02
00	14	11	01
64	00	13	01
48	03	00	03
64	00	13	01

Motion

ſig.	deg.	min.	ſec.
11	19	21	34
07	18	14	21
09	00	45	36
10	23	58	47
8	28	59	55
7	27	46	32
07	29	01	45
08	09	40	11
07	29	01	45

CHAP. IX.

Of the Subtraction of numbers which are of diverſe denominations.

1. WHen the numbers propounded to be ſubtracted are of diverſe denominations, you muſt begin with the leaſt denomination firſt, and when the number to be ſubtracted is greater than the number of that denomination from whence it is to be ſubtracted you muſt borrow from the next denomination that is greater, and you may if you will ſet down the number of the parts that it doth contein of the next inferiour denomination, directly over the number from whence ſubtraction is to be made, ſetting down the remainer in the loweſt line under that denomination, and the one that you borrowed under the next denomination a line higher to be added thereto again; as for example.

I cannot ſubſtract 3 farthings from one farthing, therefore I borrow one from the next greater denomination that is 1 penny out of 8pence, andbecauſe there are four farthings in a penny, I ſet down the number 4 over the next leſſer denomination, that is the denomination

	20	12	4
	4 —	03 —	05 — 1
	2 —	17 —	08 — 3
	1	1	1
	1 —	03 —	8 — 2

denomination of farthings, and then 1 + 4 = 5, and 5 − 3 = 2 which I ſet in the lower line under the denomination of farthings; and the one that I borrowed, I ſet in the line above it under the denomination of pence, and ſay 1 + 8 = 9, and 9 out of 5 cannot be, therefore I borrow 1 ſhilling from the next rank and ſet down the number of pence conteined in a ſhilling, that is 12 over the rank of pence, and ſay 5 + 12 = 17 and 17 − 9 = 8 which I ſet down in the lower rank under the denomination of pence, and the 1 ſhilling that I borrowed in the line above it under the denomination of ſhillings, then I ſay 1 + 17 = 18, and 18 out of 3 I cannot take, therefore I borrow 1 pound from the next rank, and ſet down the number of ſhillings conteined in one pound, that is 20 over the rank of ſhillings and ſay 3 + 20 = 23 and 23 − 18 = 5 which I ſet down in the lower line under the denomination of ſhillings, and the 1 pound that I borrowed in the line above it under the denomination of pounds, and ſay 1 + 2 = 3, and 4 − 3 = 1, and ſo 2 l. 17 8 3 being deducted from 4 l. 03 05 01 the remaner is 01 l. 05 08 2.

2. Anotner way, when the ſmaller denominations in the ſum to be ſubtracted, are greater than the like denominations in the ſum from whence the Subtraction is to be made, borrow one from the greateſt denomination in the queſtion and ſet down the number of parts leſs one, that one of the greateſt denomination doth contein of the next leſs over that leſſer denomination, and ſo orderly till come to the leaſt denomination

mination that the greateſt can be ſubdivided into, and there ſet down the full number of parts and make your Subtraction as that, ſo ſhall you have the remainer ſought; ſo in the former example, becauſe the leſſer denominations of the number to be ſubtracted are greater than the like denominations in the number from whence the ſubtraction is to be made I borrow 1 from the greateſt denomination in the queſtion, which is the denomination of pounds, and becauſe one pound doth contein 20 ſhillings, I ſet 19 over the rank of ſhillings, 11 over the rank of pence, and 4 over the rank of farthings, and then ſubtracting the loweſt line from the two lines of numbers above it the remainer is 1l. 05 08 2.

lib.	s.	d.	f.
	19	11	4
4	03	05	1
2	17	08	3
1	05	08	2

More examples of this rule are theſe following.

Troy

Troy Weight.

lib.	oun.	p.w.	Gr.
75	07	16	14
23	10	17	19
51	08	18	19
75	07	16	14

Averdupois.

lib.	oun.	dr.	ſ.
64	00	13	01
15	13	12	02
48	03	00	03
64	00	13	01

Motion

ſig.	deg.	min.	ſec.
11	13	11	22
11	23	45	16
11	19	26	06
11	13	11	22

Motion

ſig.	deg.	min.	ſec.
7	29	01	45
11	19	21	34
8	09	40	11
7	29	01	45

CHAP.

CHAP. X.

Of the Multiplication of numbers which are of diverſe Denominations.

1. When a number of diverſe Denominations is given to be multiplied by a number of but one denomination, you muſt begin firſt with the leaſt denomination, and ſo by degrees aſcend to the greateſt, adding ſtill to the greater denomination the integers of the ſame denomination, which are produced by the multiplication of the leſſer, for example, if a man ſpend 14 pound 13 ſhillings 8 pence in one day, what will he ſpend at that rate in ſeven daies? The anſwer is ſeven times as much, and therefore the expence of one day muſt be multiplied by 7 in this manner, 8 x 7 = 56, but becauſe 12 d. = 1 s. 56 d. = 4 s. 48 d. and therefore I write 8 d. in the lowermoſt line right under the denomination of pence, and the 4 in the line above it under the denomination of ſhillings. Then 13 x 7 = 91 to which the 4 being added the ſum is 95, but becauſe 20 ſhillings = 1 pound, therefore 95 ſhillings = 4 pound 15 ſhillings, and ſo I write

l.	s.	d.
14	13	08
		7
4	4	
102	15	08

write 15 shillings in the lowermost line under the rank of shillings, and 4 in the line above it under the rank of pounds. Lastly $14 \times 7 = 98$ pounds, to which the 4 pounds being added, the sum is 102. which being under written as before, the expence of the whole week will be found to be 102l. 15s. 8d.

2. when a number of diverse denominations is given to be multiplied by a number of one denomination, but greater than can be expressed with one figure, it will be convenient, that the number of diverse denominations, be reduced into a number of the least denomination given, before you begin your multiplication; and after the multiplication is finished, to reduce the product into the former denominations, if need be; for example, if 283 men were to receive 28 pound 13 shillings 9 pence a man, how much money must be paid to the 283 men? Before I begin the multiplication I must reduce the 28 pound 13 shillings 9 pence into pence, which according to the rules of reduction given will be 6885 pence. And then $6885 \times 283 = 1948455$ as by the work in the margin; and so many pence are required to pay off the 283 men, and 1948455 pence being reduced into the former denominations, they will be found equal to 8118 pound 11 shillings and 3 pence.

6885
283
20655
55080
13770
1948455

3. When a number of diverse denominations is given to be multiplied by another of diverse denominations

denominations alſo, but denominations of the ſame kind, it will be convenient to reduce both the numbers into numbers of the leaſt denomination given, before you begin your multiplication, and after your multiplication is finiſhed to reduce the product into the former denominations given; for example, let it be required to multiply 2 pound 9 ſhilling and 6 pence by it ſelf: Reduction being made according to the former directions, the number of pence in each number will be 594, and 594 pence being multiplied by 594 pence, the product will be 352836 ſquare pence, which being divided by 57600 the number of ſquare pence in a pound, the quotient will be 6 pound 2 ſhillings 6 pence, and $\frac{1}{4}$ of a farthing, as by the operation it doth appear.

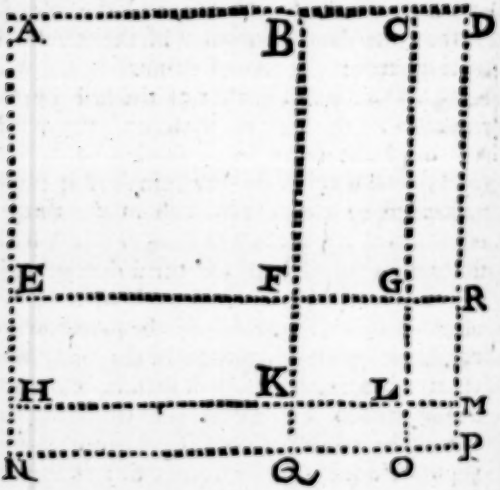
49 ſhillings	594
12	494
98	2376
496 pence.	5346
594	2970
57600	352836(6l.
29520	345600
12	7236(2s.
59040	20
29520	144720
354240	115200(6d.
345600	29520
8640	
4	
34560 that is $\frac{1}{4}$ >	
57600	

4. Another

4. Another way in the annexed Diagram, let there be two numbers of three denominations given, and let A F be the ſquare or rect angle made of the greateſt denomination in both numbers, E K and B G two rect angles made by multiplying the firſt denomination by the ſecond, the product being divided by an integer of the greateſt denomination reduced into the parts of the ſecond, the quotient ſhall be of the ſame denomination with the greateſt, and the remainer of the ſame denomination with the ſecond. F L is the ſquare of the ſecond denomination, which being divided by an integer of the firſt or greateſt reduced into the parts of the ſecond, the quotient ſhall be of the ſame denomination with the ſecond; and if there be any remainer it muſt be multiplied by a number which in the third denomination is equal to an integer in the ſecond, the quotient ſhall be of the third denomination, and if there be yet a remainer it muſt be multiplied by a number which in the fourth denomination is equal to an integer in the thid, and divided as before, the quotient ſhall be of the fourth denomination, and ſo forward till the remainer cannot be reduced into leſſer terms. And thus you have done with the ſquare or rect angle A C LH.

C R and H Q are two rect angles made by the multiplication of the ſumme of the greateſt denomination given, by the ſumme given which is of the third inferiour denomination, the product ſhall be of the ſame denomination with the third, and therefore if that product be greater than

than an integer of the ſecond denomination, reduced into the parts of the third, it muſt be divided by a number which in the third denomination is equal to an integer in the ſecond, the quotient ſhall be of the ſecond denomination, and the remainer ſhall be of the third. G M and K O are two rect angles made by multiplying the ſumme of the ſecond denomination by the third,



and the product being divided by one of the integers in the greateſt denomination reduced into the parts of the ſecond, the quotient ſhall be of the ſame denomination with the third, and the remainer muſt be multiplied by a number which in the fourth denomination is equal to an integer

in

in the third, the quotient ſhall be that fourth denomination, and the remainer ſhall be the numerator of a fraction, whoſe denominator is that former diviſor. Laſtly L P is the ſquare of the third denomination which muſt be divided if it may be by one integer of the greateſt denomination, reduced into the parts of the third, the quotient ſhall be of a fourth inferiour denomination, and the remainer ſhall be the numerator of a fraction, whoſe denominator is the ſame diviſor.

From this Diagram thus explained, the Multiplication of pounds, ſhillings and pence, by pounds, ſhillings and pence will be plain and eaſie, for,

1. Pounds multiplied by pounds produce pounds.

2. Pounds multiplied by ſhillings and the product divided by 20, the quotient will be pounds, and the remainer ſhillings.

3. Shillings multiplied by ſhillings the product will be the numerator of a fraction, whoſe denominator is 400 the ſquare of ſhillings in a pound, the value of which fraction may be found by multiplying the numerator firſt by 20, and dividing the product by 400, the quotient ſhall be ſhillings, and the remainer the fraction of a ſhilling, which being multiplied by 12 and the product divided by 400 the quotient ſhall be pence, and the remainer the fraction of a penny, which being multiplied by 4 and the product divided by 400 the quotient ſhall be farthings, & the remainer ſhall be the fraction of a farthing. Example, if 19 ſhillings were given to be multiplied by 19 ſhillings the product will be 361 for the numerator of a fraction whoſe denominator is 400,

which fraction being multiplied and divided according to the former directions the value thereof will be 18 shillings 0 pence 2 farthings $\frac{4}{10}$. Set the work thus.

```
400   361
       20
      ----
      7220 ( 18 shillings
      400
      ----
      3220     240 ( 0 pence
      3200       4
      ----     ----
        20     960   2 farthings   160/400  8/20  4/10
        12     800
```

Or thus, shillings multiplied by shillings and the product divided by 20, the quotient will be shilings, and the remainer the fraction of a shilling, as the former product 361 being divided by 20 the quotient is 18 shillings, as before, and the remainer is $\frac{1}{20}$ which being reduced is 0 d. 2 f. & $\frac{4}{10}$.

4. Pounds multiplied by pence the product is the numerator of a fraction, whose denominator is 240 the number of pence in a pound; thus 2 pounds being multiplied by 11 pence the product is 22 for the numerator to 240; now then if you multiply 22 by 20 and divide the product by 240, the quotient will be $1\frac{200}{240}$ shillings and this also being multiplied by 12 and the product divided by 240 the quotient will be 10 pence.

Or thus, pounds multiplied by pence and the productdivided by 12 the quotient will be shilings

lings and the remainer pence. Thus re-divided by 12 give 1 ſhilling 10 pence as before.

5. Shillings multiplied by pence the product will be the numerator of a fraction, whoſe denominator is 240 the number of pence in a pound, and this numerator being multiplyed by 12 and the product divided by 240, the quotient will be pence, and the remainer the fraction of a penny, which being multiplied by 4 and the product divided by 240, the quotient will be farthings and the remainer the fraction of a farthing. Example, 19 ſhillings being multiplied by 11 pence the product is 209, which being multiplied by 12 the product is 2508, and this product being divided by 240 the quotient is 10 pence and the remainer 108, which being multiplied by 4 the product is 432 and this product being alſo divided by 240 the quotient is one farthing and $\frac{192}{240}$ or $\frac{4}{5}$

Or thus, ſhillings multiplied by pence, and the product divided by 20 the quotient will be pence and the remainer the fraction of a penny, thus 209 being divided by 20 the quotient is 10 pence and one farthing and $\frac{16}{20}$ or $\frac{4}{5}$ as before.

6. Pence multiplied by pence the product will be the numerator of a fraction whoſe denominator muſt be 57600 the number of ſquare pence in a pound; which numerator being multiplied by 20, by 12 and by 4 continually, and the laſt product being divided by 57600, the quotient will be farthings, and the remainer the fraction of a farthing. Example, let 11 pence be given to be multiplied by 11 pence the product is 121, which

being multiplied by 20 the product is 2420, and 2420 being multiplied by 12 the product is 29040, and this also being multiplied by 4 the product is 116160, and this last product being divided by 57600 the quotient is 2 farthings $57\frac{960}{57600}$ or $\frac{1}{60}$. Or thus, 121 being multiplied by 4 the product will be 484, which being divided by 240 the number of pence in a pound, the quotient will be two farthings $1\frac{4}{240}$ or $\frac{1}{60}$ as before. For illustration of these 6 rules which are deduced from the preceeding Diagram, let 2 pounds 19 shillings and 11 pence be given to be multiplied by 2 pound 19 shillings and 11 pence, set the numbers as here you see.

lib.	s.	d.		
2	19	11		
2	19	11		
4	00	00		
1	18	00		
1	18	00	2	4
0	18	00	0	0
0	01	10	0	0
0	01	10	1	8
	00	10	1	8
	00	10	2	1667
8	19	6	0	1667

Where two pounds multiplied by two pounds makes 4 pounds by the first rule, and 2 pounds multiplied by 19 makes 1 l. 18 s. by the second rule, which must be set down twice, and 19 shillings

lings multiplied by 19 ſhillings do make 18 0 2 $\frac{4}{16}$ by the third rule, then 2 pounds multiplied by 11 pence do make 1 ſhilling 10 pence by the fourth rule, and this muſt be ſet down twice, 19 ſhillings multiplied by 11 pence, do make 10 pence farthing $\frac{8}{16}$ by the fifth rule, and this muſt be ſet down twice; laſtly 11 pence multiplied by 11 pence do make two farthings, 16667 parts of a farthing by the fixth rule, and ſo the whole product is 8 19 06 0 1667.

2 *Example in board meaſure.*

Let the length of a board be 14 feet 6 inches and 3 quarters of an inch, and let the breadth be 2 foot 9 inches and 3 quarters, and let the content of that board be required. According to the firſt way you muſt reduce the length and breadth into the leaſt denomination, ſo is the the length of this board 699 quarters of an inch, and the breadth 135; and 699 being multiplied by 135 the product is 94365.

And in a foot of board there are 144 inches or 2304 quarters, by which if you divide 94365 the quotient will be 40 feet and $\frac{2205}{2304}$ parts of a foot; the numerator of which fraction being multiplied by 12 the product is 26460, and this product being divided by 2304 the quotient is 11 inches and the remainer is 1116, which multiplied by 4 the product is 4464 which being alſo divided by 2304 the quotient is 1 quarter and the remainer is $\frac{1560}{2304}$ or $\frac{13}{19}$ of a quarter, and ſo the content

of that board is 40 feet 11 inches and $\frac{1}{2}$ and $\frac{11}{12}$ of a quarter.

The Second Way.

If you multiply 14 by 2 the product is 28 feet by the first rule. Secondly 14 feet by 9 inches makes 126 inches, and 2 feet by 6 inches makes 12 inches more, in all 138, which being divided by 12, the quotient is 11 feet 6 inches. Thirdly, 6 inches by 9 inches makes 54, which being divided by 12 the quotient is 4 inches and a half. Fourthly, 14 feet by 3 quarters of an inch makes 42, and 2 feet by 3 quarters makes 6 more, in all 48, which being divided by 12 the quotient is 4 quarters or one foot. Fifthly, 6 inches by 3 quarters make 18, and 9 inches by 3 quarters make 27, in all 45, which being divided by 12 the quotient is 3 quarters and $\frac{9}{12}$ or $\frac{3}{4}$ of a quarter or $\frac{75}{100}$. Sixthly, 3 quarters by 3 quarters makes $\frac{9}{16}$ which is the numerator of a fraction whose denominator is 48 the number of quarters in a foot, and $\frac{9}{48}$ is equal to $\frac{3}{16}$ or $\frac{1875}{10000}$ and so the content of this board is 40 feet 11 inches 1 quarter and $\frac{11}{12}$ of a quarter, as here you see; for $\frac{9}{16}$ more $\frac{9}{48}$ being reduced as shall be shewed in the doctrine of vulgar fractions, are equal to $\frac{11}{12}$.

f.	w.	q.
28	00	00
11	06	00
00	04	02.
01	00	00
00	00	03 $\frac{9}{16}$
00	00	00 $\frac{9}{48}$

3. *Exampl*

3 *Example.*

Let there be given in Aſtronomical fractions 23 degrees, 14 minutes, 32 ſeconds, to be multiplied by 17 degrees, 37 minutes, 25 ſeconds. The antient Aſtronomers have divided the Circles in which the Sun and other Planets do move into 12 equal parts and called them ſigns; each ſign into 30 degrees, ſo that they have divided the whole circle into 360 degrees, each degree into 60 minutes, and each minute into 60 ſeconds, and each ſecond into 60 thirds, and ſo forward as far as you pleaſe. And hence ſeconds being multiplied by ſeconds, produce fourths, ſeconds by minutes, thirds, and ſeconds by degrees, minutes; only you remember that if the products ſhall at any time exceed 60, ſo many ſixties as it doth exceed muſt be transferred to the product of the next greater denomination, as by the operation it doth appear.

Diviſor, multiply the remaining part of your Dividend by the number of parts in the next inferiour Denomination, and to the product add the parts of that Denomination given, if there be any in the ſumme propounded, and then proceed as before; ſo ſhall you at laſt produce the whole quotient ſought. Example, let it be required to divide 102 pounds 15 ſhillings 8 pence, into 7 equal parts or among ſeven men, you muſt place the numbers as hath been ſhewed before, then ask how often 7 in 10, the anſwer is once, therefore I write 1 in the quotient, and deducting 7 out of 10 the remainer is 3, to which I draw down 2, the next figure in the dividend, and it maketh 32, then I ask how often 7 is contain in 32, the anſwer is 4, which I ſet in the tient, then I multiply 7 by 4, the figure laſt p in the quotient, and the product 28 being ſub ed from 32, the remainder is 4, which bei than 7, I multiply 4 by 20 the number of

in

lib.	s.	d.	lib.	s.	d.
7) 102	15	08	(14	15	08

7

32
28

4
20

80
15 (13 ſhillings

56 (8 pence
56

00

in the next inferiour Denomination, and the product is 80, to which I adde the 15 ſhillings in the queſtion, and then the ſumme is 95, which being

Sig.	Deg.	Min.	Sec.	Thir.	Fourt.
	23	14	32		
	17	37	25		
			115	70	160
			460	280	64
		161	98	224	
		690	420	96	
	161	98	224		
	230	140	320		
	391	1089	1637	1534	800
	18	27	15	13	
	409	1116	1652	1547	
13	19	36	32	47	20

In which first you have the *Indices* or exponents of the several denominations, and in the two next lines the Multiplicand, and Multiplicator, and beginning with the least denominations first, I multiply 32 seconds by 25 seconds, and the product I set it under the denomination of fourths, because seconds multiplied by seconds produce fourths, then I multiply 14minutes by 25 seconds, and the product I set under the denomination of thirds, because minutes multiplied by seconds produce thirds: thirdly I multiply 23 degrees by 25 minutes, and I set their product under the denomination of seconds, because

cauſe degrees multiplied by ſeconds, produce ſeconds; and this muſt be alſo done with the ſecond and third numbers in the multiplicator. Then adde together all the products under every particular denomination by themſelves, ſo will the product under the denomination of fourths, be 800, which being divided by 60 the quotient is 13, and the remainer 20, therefore I ſet down 20 under the denomination of fourths, and carry 13 to the next rank, in which the ſumme of the product is 1534, to which the 13 being added, it makes 1547 which being divided by 60 the quotient is 15, and the remainer 47, therefore I ſet down 47 under the denomination of thirds, and carry 15 to the next rank, till I have finiſhed the whole work, and ſo the product at laſt is 13 ſigns, 19 degrees, 36 mintes, 32 ſeconds, 47 thirds, and 20 fourths.

CHAP. XI.

Of the Diviſion of numbers which are of diverſe denominations.

1. WHen a number of diverſe Denominations is given to be divided by a number of but one Denomination, you muſt begin with the greateſt Denomination and divide the number given, as hath been ſhewed in the Diviſion of whole numbers, and when you have proceeded ſo far in your Diviſion, that the Dividend is become leſs than the Diviſor,

Diviſor, multiply the remaining part of your Dividend by the number of parts in the next inferiour Denomination, and to the product add the parts of that Denomination given, if there be any in the ſumme propounded, and then proceed as before; ſo ſhall you at laſt produce the whole quotient ſought. Example, let it be required to divide 102 pounds 15 ſhillings 8 pence, into 7 equal parts or among ſeven men, you muſt place the numbers as hath been ſhewed before, then ask how often 7 in 10, the anſwer is once, therefore I write 1 in the quotient, and deducting 7 out of 10 the remainer is 3, to which I draw down 2, the next figure in the dividend, and it maketh 32, then I ask how often 7 is contained in 32, the anſwer is 4, which I ſet in the quotient, then I multiply 7 by 4, the figure laſt placed in the quotient, and the product 28 being ſubtracted from 32, the remainder is 4, which being leſs than 7, I multiply 4 by 20 the number of parts

in

lib.	s.	d.	lib.	s.	d.
7) 102	15	08	(14	15	08

7
32
28
4
20
80
15 (13 ſhillings
95
7
25
21
4
12
48
8
56 (8 pence
56
00

in the next inferiour Denomination, and the product is 80, to which I adde the 15 ſhillings in the queſtion, and then the ſumme 195, which being

being divided by seven, the quotient is 13, and the remainer 4, which being multiplied by 12, the number of parts in a shilling, the product is 48 pence, to which I adde the 8 pence in the question, and then the sum is 56, which being divided by 7, the quotient is 8, and nothing remains, and so the whole quotient is 14l. 15 s. and 8 d.

In like manner 8118l. 11s. 3d. being given to be divided by 283, the quotient will be 28l. 13 s, 9 d. as by the following operation doth appear.

lib.	s.	d.	l.	s.	d.
283) 8118	11	3	(28	13	09
566					
2458	212				
2264	12				
192	424				
20	2123				
3880	2547	(9 d.			
11	2547				
3891 (13					
283					
1061					
849					
212					

3. When

3. When a number of diverſe Denominations is given to be divided by a number of diverſe denominations alſo, it will be convenient to reduce both the numbers into numbers of the leaſt denomination given, before you begin your Diviſion, and after Diviſion is finiſhed to reduce the quotient into the ſeveral denominations in which the number was given.

For example, let it be required to divide 6 l. 2s. 6 d. $\frac{1}{2}$, by 2 l. 9 s. 6 d. To reduce this Dividend into ſquare pence, the ordinary way of Reduction will not ſerve, for this Dividend is the quotient of a certain number of ſquare pence, divided by 57600 the number of ſquare pence in a pound ſterling, and therefore to make this ſumme given fit for Diviſion, it muſt be multiplied by 57600; and to do this it will be proper to begin with the leaſt denomination firſt, which in this example is a fraction, and a fraction reduced into its leaſt terms, ſo that the firſt work will be to find the greater fraction, to which the fraction given is æquivalent, and this is eaſily done, for 57600 is the denominator; now then, as 5 to 3, ſo 57600 to 34560 the numerator ſought; and this being divided by 4 the number of farthings in a penny, gives me the laſt remainer, before this 34560, viz. 8640: now pence being the next greater denomination, I multiply 57600 by 6, the number of pence in the Dividend, the product is 345600, to which adding 8640, the number before found, the total is 354240 which being divided by 12, the number of pence in a ſhilling, the quotient is 29520; and becauſe the number of ſhillings in the

ſumme

ſumme given, is 2, I multiply 57600 by 2, the product is 115200 to which 29520 being added, the total is 144720 which muſt be divided by 20, the quotient will be 7236, and ſo we have done with the ſhillings and pence in the queſtion; laſtly I multiply 57600 by 6 the number of pounds propounded, and the product is 345600, to which 7236 being added, the total is 352836, and ſo at length the number given is fitted and prepared for Diviſion; the Diviſor according to the ordinary way of Reduction, will be found to be 594, by which dividing 352836 the quotient will be 594 alſo, as by the work appeareth. And this

```
594 ) 352836 ( 594
      2970
      ----
      5583
      5346
      ----
       2376
       2376
       ----
```

quotient being reduced is 2l. 9s. 6d. the quotient ſought.

4. This queſtion and all others of the like nature may be alſo reſolved without reducing both numbers at the firſt, in this manner. Firſt ſet down the *indices* of the ſeveral Denominations given, and the Dividend under thoſe *indices*, and the Diviſor under the Dividend, then ask how often the greateſt Denomination in the Diviſor is contained

teined in the greateſt Denomination in the Dividend, and put the anſwer in the quotient, then multiply all the Denominations in the Diviſor, by the figure in the quotient, and the product being deducted from the Dividend, ſet down the remainer, and ſo proceed to the next, and work in like manner, ſo ſhall you at laſt have the quotient deſired.

Example, let 6 pound 2 ſhillings 6 pence ½ be given to be divided by 2 pounds 9 ſhillings 6 pence. The numbers being ſet as here you ſee, I ask how often 2 is conteined in 6, and the anſwer is 3 times, but 2 pound 9 ſhillings cannot be had but twice in 6 pound 2 ſhillings, therefore I put 2 l. in the quotient, and multiply the Diviſor 2 l. 9 s. 6 d. by 2. and the product 4 l. 19 s. being deducted from 6 l. 2 s. the remainer is 1 l. 3 s. 6 d and ſo have I wrought once; then I ask how often 2. is conteined in 1 l. 3 s. that is in 23 s. the anſwer is 11,

l.	s.	d.	q.	ten.	
6	2	6	00	6	
2	9	6			
4	19	0			2 lib.
1	3	6	00	6	
1	2	3	01	2	9 ſhil.
	1	2	3	4	
	1	2	3	4	6 d.

but I can take but 9 s. becauſe of the following figures, therefore I put 9 ſhillings in the quotient, and

and multiply 2l. 9s.6d. by 9. and the product is 1l. 2 s. 3 d. 1 farthing and 2 tenths, which being deducted from 1 l. 3s. 6 d. 0 far. and 6 tenths, the remainer is 1 ſhilling, 2pence, 3 farthings, and 4 tenths, and ſo I have wrought twice. Then I ask how often 2. in 1s. 2d. and the anſwer is 6, therefore I put 6 pence in the quotient, and multiply 2 pounds 9 ſhillings and 6 pence by 6, and the product is 1 ſhilling, 2 pence, 3 farthings, and 4 tenths, which being deducted from 1 ſhilling 2 pence 3 farthings and 4 tenths, the remainer is nothing, and ſo the quotient is 2l. 9 ſhillings and 6 pence.

5. In Aſtronomical fractions, let it be required to divide 13 ſigns, 19 degrees, 36 minutes, 32 ſeconds, 47 thirds, and 20 fourths, by 17 degrees, 37 minutes, 25 ſeconds; firſt ſet down the *indices* or ſeveral Denominations of Aſtronomical fractions given, and under them write the number of the parts belonging to each Denomination, as they are propounded in the Dividend, and ſet your Diviſor either under the Dividend as here you ſee, or in what other place you pleaſe.

S.	D.	M.	S.	T.	F.	
13	19	36	32	47	20	Dividend
	17	37	25			Diviſor
13	15	20	35			23 deg. Quotient
0	04	15	57	47		
	4	06	43	50		14 min.
	00	09	13	57	20	
	00	09	13	57	20	32 ſec.

Then beginning at the left hand, ask how oft the number of the greateſt denomination in the Diviſor, can be had in number of the greateſt denomination in the Dividend; but if your Diviſor be greater than the firſt number in your Dividend, place your Diviſor one ſtep farther, towards your right hand. Thus in our example, becauſe 17 is not conteined in 13, the greateſt denomination in the Dividend, therefore I ſet it a place forwarder, towards the right hand, that is under 19 deg. and then reducing the 13 ſigns into deg. by multiplying them by 30, the product is 390, to which the 19 being added, the ſumme is 409, in which 17 is conteined 23 times, therefore multiplying the Diviſor 17 deg. 37 min. 25 ſec. by 23, the product is 13 ſig. 15 deg. 20 min. 35 ſec. which being deducted from the Dividend, the remainer is 04 deg. 15 min. 57 ſec. and to this remainer, I draw down the number of parts in the next leſſer Denomination, and then I ask how oft 17 is conteined in 4 deg. 14 min. and the anſwer is 14 times, which I place in the Quo-

tient, and multiplying the Diviſor 17 deg. 37 min. 25 ſec. by 14, the product is 04 deg. 06 min. 43 ſec. 50 thirds, which being deducted from the Dividend, as before, the remainer will be 9 min. 13 ſec. 57 thirds, and unto this remainer I draw down the number of parts in the next leſſer denomination, and then proceeding as before, I ask how oft 17 in the Diviſor is conteined in 9 min. 13 ſec. in the Dividend, and the anſwer is 32, which I ſet in the Quotient, and thereby alſo I multiply the Diviſor as before, and the product is 9 min. 13 ſec. 57 thirds, 20 fourths, there remaineth nothing, and ſo at laſt, I find the Quotient to be 23 deg. 14 min. 32 ſec.

CHAP. XII.

Of the Reduction of Vulgar Fractions.

1. HItherto hath been ſhewed the Numeration of ſuch broken numbers or fractions as are many times expreſſed like integers: Numeration of ſuch broken numbers, or fractions as are expreſſed by their numerators and denominators now followeth, and theſe broken numbers, are commonly called natural or vulgar fractions.

2. The numeration of vulgar fractions is either accidental or eſſential.

3. Accidental numeration, otherwiſe called Reduction, is that which changeth or reduceth the terms

terms of the parts given, without changing or altering of their value.

4. Reduction or accidental numeration is either of parts to parts, or integers to parts.

5. Reduction of parts to parts, is that which findeth other parts, that are proportional to the parts given, and this three waies.

1. By reducing the parts given into their least terms, if they be not in their least terms already.

2. By reducing fractions of unequal denominations into fractions of the same value, whose denominator shall be equal.

3. By reducing fractions of diverse denominations into fractions of any denomination that shall be desired.

6. Reduction of parts or fractions into their least terms, is performed by finding out a common measure to both parts of the fraction given, that is by finding out the greatest number, which will measure or divide each of the numbers given, without leaving any remainer.

7. The greatest common measure of two numbers given may be found by dividing the greater by the less, and the divisor by the remainer, and so continually untill nothing doth remain, the last divisor is the common measure sought: Example, let it be required to find the greatest common measure unto 63 and 14, set your numbers as hath been directed in Division of whole numbers, thus.

14)63(4
56
---
7)14(2
14

00

Then I ask how often 14 in 63, the answer is 4 times, therefore I put 4 in the quotient, and multiply 14 by 4, and the product 56 I set under the Dividend 63, and substracting 56 from 63 the remainer is 7, then I divide 14 by 7 the quotient is 2, and the remainer 0, therefore 7 the last divisor is the common measure sought.

8. The common measure of any two numbers which do constitute a fraction, being thus found, the said fraction may be reduced into its least terms, by dividing the numerator and denominator by the common measure, for the quotients will be the numerator & denominator of the fraction, and in the least terms. So if the fraction $\frac{14}{63}$ be given to be reduced into the least terms, the common measure being 7, I divide 14 by 7, and the quotient is 2 for a new numerator, and dividing 63 by 7, the quotient is 9 for a new denominator, and so the fraction $\frac{14}{63}$ is reduced into its least terms that is into the fraction $\frac{2}{9}$, but if the greatest common measure unto the numerator, and the denominator given shall be 1, such fraction is in its least terms already; so the fraction $\frac{13}{17}$ cannot be reduced into lower terms, because the greatest common measure is 1. This is a general rule for the reduction of fractions into their least terms;

but

but yet even this may be sometimes shortened, for when the numerator and denominator are eaven numbers they may be measured or divided by 2. As if 16 were the numerator, and 64 the denominator, draw a line at length between them to separate the numerator from the denominator, and cross the same with a down right stroke near the fraction as here you see in the margin. Then take the half of 16 which is 8 for a new numerator, and the half of 64 which is 32, for a new denominator, again the half of 8 is 4, and the half of 32 is 16, and so proceeding in like manner there will be found $\frac{1}{4}$ equivalent to $\frac{16}{64}$. The like abbreviation will be found, when the numerator and denominator do both end with 5, or one of them ending with 5, and the other with a cypher, for then the fraction may be reduced into its least terms, by dividing both parts of the fraction given, by 5. Thus if it were required to reduce the fraction $\frac{125}{345}$ dividing 125 by 5, the quotient will be 5, and dividing 345 by 5, the quotient will be 19, and so the fraction $\frac{125}{345}$ is reduced to the fraction $\frac{5}{19}$.

9. Reduction of fractions to the same denomination is performed by multiplying the numerator of each fraction into all the denominators continually except its own, for so the several products which arise by such continual multiplication, shall be the new numerators; and the product found by multiplying all the denominators continually, shall be the common denominator to all those new numerators. As in the

following examples $\frac{1}{4}$ and $\frac{1}{6}$ I multiply 3 by 6, and they make 18, and 5 by 4, and they make 20, for the two numerators, then I multiply 4 by 6 and the product is 24 for the common denominator, and so the fractions $\frac{1}{4}$ and $\frac{1}{6}$ are reduced into the fractions $\frac{18}{24}$ and $\frac{20}{24}$, or being reduced into their least terms $\frac{3}{4}$ and $\frac{10}{12}$, as by the work appears.

Thus if the fractions $\frac{2}{5}$ $\frac{3}{7}$ and $\frac{4}{9}$ were propounded, here I multiply 2 by 7 and 9 continually, and they make 126, also I multiply 3 by 5 and 9, and the product is 135, in like manner I mulmultiply 4 by 5 and 7 and the product is 140, and these three products are three new numerators, lastly I multiply 5 7 and 9 continually, and the product 315 is the common denominator to all the numerators.

$\frac{2}{5}$ $\frac{3}{7}$ $\frac{4}{9}$

$\frac{126}{315}$ $\frac{135}{315}$ $\frac{140}{315}$

10. But if the fractions propounded, be compounded fractions, or fractions of fractions, they must be reduced into single fractions, by multiplying all the numerators continually for a new numerator, and all the denominators continually for a new denominator. Thus if $\frac{2}{3}$ of $\frac{3}{4}$ of $\frac{4}{5}$ were given, the product of the numerators 2 3 4 is 24; and the product of the denominators 3 4 and 5 is 60, and so the fractions $\frac{2}{3}$ of $\frac{3}{4}$ of $\frac{4}{5}$ are reduced to $\frac{24}{60}$ or $\frac{2}{5}$

11. The

11. The Reduction of integers to parts is either of whole or mixt numbers.

12. A whole number is reduced into an improper fraction by placing the whole number given as a numerator, and one as a denominator, thus twelve integers will be reduced into the improper fraction $\frac{12}{1}$

13. A mixt number may be reduced into an improper fraction, by multiplying the whole part of the mixt number, by the denominator of the fraction given, and adding to the product the numerator of the ſaid mixt number thus $4\frac{7}{12}$ is reduced into the improper fraction $\frac{55}{12}$, for 4 being multiplied by 12 the product is 48, to which if you add 7, the ſumme is 55 for a new numerator, which being placed over the denominator 12, gives the improper fraction $\frac{55}{12}$ equal to the mixt number $4\frac{7}{12}$

14. Fractions of diverſe denominations may be reduced into fractions of any denomination deſired by multiplying the numerator given by the denominator required, and dividing the product by the denominator given, for ſo the quotient ſhall be the numerator required.

Example, let the fraction given be $\frac{7}{8}$ of a pound ſterling, and let it be deſired to know what that is in the $\frac{15}{20}$ of a pound, multiply 7 by 15, the product is 105, which being divided by 8 the Quotient is $13\frac{1}{8}$ that is 13 ſhillings and 13 groats, that is 17 ſhillings and 4 pence and $\frac{1}{8}$ of a pound that is 16 pence, which being alſo divided by 8 the quotient is 2 pence, which being added to 17 s. 4 d. the whole is 17 s. 6 d. and ſo the fraction $\frac{7}{8}$

is reduced to the equivalent fraction $\frac{104}{11}$ or which is all one to the improper fraction $13\frac{1}{11}$ as was propounded. And by this rule may any other fraction given, be reduced to another equivalent fraction, that shall have any denomination assigned, and is of excellent use for the converting of vulgar fractions into decimals, and the contrary, as shall be farther shewed in its proper place.

CHAP. XIII.

Of the Addition and Subtraction of vulgar fractions.

1. REduction of fractions I call accidental numeration, yet is the knowledge thereof very essential, for that being well understood, the essential numeration of vulgar fractions cannot be difficult; whose parts as in whole numbers are these four, addition, subtraction, multiplication and division.

2. Vulgar fractions whether proper or improper, being reduced to fractions of the same denomination, if need be, may be added like whole numbers, still keeping the same denominator, so $\frac{1}{5}$ and $\frac{2}{5}$ being given to be added, their summe is $\frac{3}{5}$.

3. Vulgar fractions whether proper or improper being reduced into fractions of the same denomination, if need be, may be subtracted one from another like whole numbers, keeping still the

the ſame denominator. Thus if the fraction $\frac{2}{3}$ were to be ſubtracted from the fraction $\frac{5}{6}$ the difference will be $\frac{1}{6}$.

CHAP. XIV.

Of the Multiplication and Diviſion of vulgar fractions.

1. WHen Vulgar fractions whether proper or improper are given to be multiplied, (being reduced to ſingle fractions, if need require) multiply the numerator of the one, by the numerator of the other, ſo is the product a new numerator, alſo multiply the denominator of the one, by the denominator of the other, and ſo ſhall the product be a new denominator, and this new fraction is the product ſought. Example.

Let the fractions $\frac{5}{7}$ and $\frac{3}{4}$ be given to be multiplied, if you multiply the numerator 5 by the numerator 3, the product is 15 for a new numerator, alſo if you multiply the denominator 7 by the denominator 4, the product is 28, for a new denominator, and ſo the fraction $\frac{15}{28}$ is the product of the fractions given.

2. When vulgar fractions whether proper or improper be given to be divided, they muſt be reduced into ſingle fractions if need require, then multiply the denominator of that fraction wch is the diviſor by the numerator of that fraction which is the

the dividend, ſo is the product a new numerator, alſo multiply the numerator of that fraction which is the diviſor, by the denominator of that fraction which is the dividend, ſo is the product a new denominator, and this new fraction is the quotient ſought. Example.

Let the fraction $\frac{2}{7}$ be given to be divided by the fraction $\frac{3}{4}$, the quotient will be $\frac{8}{21}$, for multiplying 4 by 2, the product is 8 for a new numerator, alſo multiplying 3 by 3 the product is 9 for a new denominator, and the fraction $\frac{8}{9}$ the quotient ſought; and the work ſtandeth thus $\frac{3}{4}) \frac{2}{7} (\frac{8}{21}$.

2. But if the fraction $\frac{3}{4}$ of $\frac{4}{5}$ of $\frac{1}{3}$ be given to be divided by the fraction $\frac{2}{7}$ of $\frac{4}{7}$, theſe compounded fractions muſt be reduced into ſingle fractions by the tenth rule of the twelfth Chapter, and then divided as before; thus the fraction $\frac{3}{4}$ of $\frac{4}{5}$ of $\frac{1}{3}$ will be reduced to $\frac{12}{60}$ and the compounded fraction $\frac{2}{7}$ of $\frac{4}{7}$ will be reduced to $\frac{8}{49}$ and the fraction $\frac{12}{60}$ being divided by the fraction $\frac{8}{49}$ the quotient will be $\frac{147}{160}$ as by the work appeareth. $\frac{8}{49}) \frac{12}{60} (\frac{147}{160}$

CHAP.

CHAP. XV.

Of the Notation of Decimal fractions.

1. THe Notation of fractions in the general hath been ſhewed in the ſixth Chapter, and theſe which for their excellent uſe are eſteemed, as it were another part of Arithmetick, and from their denominator called Decimals, are in reality no other than vulgar fractions, and expreſſed like them, as $\frac{5}{10}$, $\frac{25}{100}$, $\frac{125}{1000}$. but have alſo this property belonging to them, which vulgar fractions in the general have not; namely, that they may be as well expreſſed without their denominators as with them; by ſetting only a point before them; thus ·5 doth ſignifie five tenths, as fully, and as plainly, as the writing of it thus $\frac{5}{10}$.

2. When the Numerator hath not ſo many places as the Denominator hath Cyphers, ſupply thoſe places by ſetting ſo many cyphers as there are places wanting, before the numerator given, thus $\frac{25}{1000}$ may be as well expreſſed thus ·025.

3. Decimal fractions are ſo like unto integers, that the parts of ſingle Arithmetick in whole numbers being well underſtood, the ſame parts of Arithmetick in Decimal fractions, may eaſily be conceived; the greateſt difference is in the reading of the value of their notes and periods; which is directly contrary unto that of whole numbers; for in the one, to wit, in whole numbers, we reckon

unites

unites, tens, hundreds, thousands and so forward from the right hand to the left, but in Decimal fractions we reckon tenths of unity, hundreds of unity, thousands from unity, and so forward from the left hand to the right, as doth very clearly appear by the following Table.

9	6	3	4	7	6	5	8	3
Fifth place	Fourth place	Third place	Second place	First place	First place	Second place	Third place	Fourth place

In this Table you may observe that the places of Decimal parts are separated from the place of unity in whole numbers by a line drawn between them, so that the number on the left hand of that line expresseth 9 6 3 4 7 integers or unities; and the number on the right hand of the line 6 5 8 3 expresseth the parts of an unite, or an integer divided into 10000 equal parts, in like manner this number 7 6 doth signifie 7 integers, and eight tenth parts of an integer, and this number 3 4 7 · 6 5 doth signifie 347 integers or unities, and 65 decimal parts of an integer.

CHAP.

CHAP. XVI.

Of the Reduction of vulgar fractions into Decimal fractions.

1. HAving ſhewed the notation of Decimal fractions, I come now unto their numeration, the which as in vulgar fractions, is accidental or eſſential.

2. Accidental numeration, is the Reduction of vulgar fractions into Decimals, and this may be performed by the fourteenth rule of the twelfth Chapter, where is ſhewed how fractions of diverſe denominations, may be reduced into fractions of any denomination deſired; namely by multiplying the numerator given, by the denominator required, and dividing the product by the denominator given; now then to apply this rule to decimal fractions, let it be required to reduce this vulgar fraction $\frac{5}{8}$ of a pound into a fraction, whoſe denominator ſhall be 1000; multiply 5 the numerator given by 1000 the denominator deſired, and the product is 5000, which being divided by 8 the denominator given, the quotient is 625 the numerator anſwering to 1000 the denominator deſired, and ſo the vulgar fraction $\frac{5}{8}$ is reduced into the decimal fraction $\frac{625}{1000}$.

3. Upon this ground the known or accuſtomary parts of money, weight, meaſure, time, motion, &c. may be reduced unto decimals; and firſt for money, if you deſire to know what decimal fraction is equal to one ſhilling, or $\frac{1}{20}$ of a pound

pound, assigning the denominator of that decimal to be 100, the numerator thereto by the last rule will be found to be 5 so that $\frac{5}{100}$ or ·05 is a decimal fraction equal in value, to one shilling or $\frac{1}{20}$ part of a pound sterling.

In like manner if the Decimal answering to $\frac{9}{12}$ of $\frac{1}{20}$ of a pound were required, that is the decimal of 9 pence, the compounded fraction $\frac{9}{12}$ of $\frac{1}{20}$ being reduced to a single fraction is $\frac{9}{240}$, now then if you assign the denominator of that decimal to be 1000, the numerator thereto by the last rule, will be found to be 375, so that $\frac{375}{1000}$ or ·0375 is a decimal fraction equal in value to 9 pence or $\frac{9}{240}$ of a pound sterling.

Or if the decimal answering to $\frac{3}{4}$ of $\frac{1}{12}$ of $\frac{1}{20}$ of a pound were required, that is the decimal of 3 farthings, the compounded fraction $\frac{3}{4}$ of $\frac{1}{12}$ of $\frac{1}{20}$ being reduced into a single fraction is $\frac{3}{960}$, now then if you assign the denominator of that decimal to be 10·000·000 the numerator thereto by the last rule will be found to be 31250, so that $\frac{31250}{10000000}$ or ·0031250 is a decimal fraction equal in value to $\frac{3}{960}$ of a pound sterling. And hence it appears, that to find the decimal answering to any number of shillings, you must multiply the shillings propounded by the denominator 10000 &c. and divide the product by 20, the number of shillings in a pound sterling.

And to find the decimal answering to any number of pence, you must multiply the pence propounded by the denominator 10000 &c. and divide the product by 240 the number of pence in a pound sterling.

And

And to find the decimal answering to any number of farthings, you must multiply the number of farthings propounded by the denominator 100000, and divide the product by 960, the number of farthings in a pound sterling.

The decimal answering to any known parts of money, weight, measure, &c. may be otherwise found in this manner; suppose a pound sterling to be divided into 1·0000000 equal parts, then doth ·1·0000000 represent one integer, or 20 shillings, and the half thereof 0·50000000 is the decimal of 10 shillings & 0·500000 is the decimal of one shilling, and the half thereof 0·0250000 is the decimal of six pence, and the half thereof is the decimal of 3 pence, to wit, 0·01250000, and a third of 0·01250000 to wit 0·00416667 is the decimal of a penny, the half of the decimal of a penny *viz.* 0·00208333 is the decimal of half one penny, and the half of that, to wit, 0·00104166 is the decimal of a farthing, and by either of these waies may a Table be made to shew the decimal of any number, of shillings, pence and farthings.

5. But if any dislike this, because the decimals of some parts of a pound cannot be exactly found (though it may be thus found so infinitely near that all questions may be resolved without considerable, though not without sensible errour) yet to satisfie the curiosity of such as shall make this objection, let them make the third part of a pound to be the integer, that is six shillings and eight pence, so may they have the decimal of any number of shillings, pence and farthings exactly, as by the following operation doth appear.

Let

Let 6s. 8d. be dividedinto	1·000000
Then ſhall the decimal of 8d. be	0·100000
The decimal of 4 d. ſhall be	0·050000
The decimal of 2d.	0·025000
The decimal of 1 penny	0·012500
The decimal of 2 farthings	0·006250
The decimal of 1 farthing	0·003125

6. The like may be done for weights and meaſures, but as for weights there will be no great advantage by turning them into decimals, becauſe all queſtions concerning them may be more conveniently reſolved without them; and as for meaſures, eſpecially long meaſures, there needs no reduction of them, for the foot, yard or chain for meaſuring of land, being divided firſt into ten equal parts, and then each of thoſe into ten other equal parts, they will be more uſeful, than as they are now uſually divided.

7. And in Aſtronomical fractions, the Reverend, Learned, and the famous *Oughtred* in the 1 Chap. of his key to the Mathematicks, doth tell us, that this Decimal Logiſtica or accounting is much eaſier and neater than that Sexagenary commonly uſed; which he plainly perceived, ſaith he, whatſoever he was, that firſt reduced the Canon of Sines, from a Semidiameter of 60 parts, unto 1 with circles or cyphers annexed, and wiſheth that the ſame were alſo done in all other Aſtronomical Canons; how ſuch fractions therefore may be converted into decimals, the following examples will ſufficiently declare.

For as much as 60 minutes make a degree, 60 ſeconds

seconds a minute, 60 thirds a second, and so forward as far as you please; if you divide the minutes given with cyphers, annexed by 60, the quotient shall be the decimal sought; thus if the decimal of 45 minutes were required, I divide 450000 &c. by 60, and the quotient is 75 for the decimal of 45 minutes, if the decimal of seconds be required, your divisor must be 3600, if the decimal of thirds be required, your divisor must be 216000, and 12960000 for fourths.

But if there be diverse Sexagesimal Species joined to integers, suppose 127 deg. 32 min. 00 sec. 09 thirds, 45 fourths, you may use this compendium; under the integers 127 set the Sexagesimal species in an oblique descent, as here you see in the margin, then beginning at the lowest, divide every of them continually by 6, and setting the quotients over their heads join them to the row next above until you come to the integers, so shall the last quotient be the Decimal sought, *Oughtred's Clavis*, Chap. 6.

127 d.
32 m.
00 s.
09 t.
45 f.

Thus 45 fourths being divided by 6 the quotient is 7, and the next dividend 09·75 which being also divided by 6 the quotient is 1625, and the next dividend 00·1625 which being also divided by 6, the quotient is 002708333 and the next dividend 32·002708333 fourths which being divided by 6 the quotient is the decimal sought.

127·5333784722
32·002708333
00·1625
09 75
45
533378472 2

8. When a decimal fraction is given, and the value thereof in the known parts of the Integer is required, multiply the decimal propounded, by the number of known parts of the next inferior denomination, which are equal to the Integers, and from that product cut off as many figures towards the right, as the Decimal given doth consist of places, the figures remaining are the value of that fraction in the next inferior denomination; and the value of the remaining part of the decimal given in the next inferior denomination may be found by the same rule, and so forward till you come to the last known parts.

Example, let the value of this decimal ·98563, be required in the known parts of a pound sterling, this decimal 98563 being multiplyed by 20, that product is 19) 71260, from which I cut off five figures, the rest are 19 shillings, and the figures cut off namely 71,260, being multiplied by 12 the product is 8·55120, that is 8 pence and 55120 parts of a shilling, which being multiplyed by 4, the product is 2,220480 that is 2 farthings, and the remainer 20480 are the decimal parts of a farthing, and so the value of the decimal fraction given is 19 shillings 8 pence ½ penny.

98563
20
19.71260
12
1·42520
71260
8.55120
4
2·20480.

But the value of a decimal fraction in the known parts of a pound, may be known by inspection, for the first figure doubled, gives the number of shillings the two next figures are the farthings, thus in the decimal given 98563 the figure 9 being doubled is

18

18 shillings, and 85 farthings that is 21 pence and a farthing; but more exactly thus, from 85, deduct 75 which is the decimal of 18 pence the remainer is 10 farthings or 2 pence half penny; that is in all 19-8d, 2 farthings as before.

If the decimal fraction given whose value is inquired be the decimal of the degree for a circle, you must divide the decimal given by six continually, and write the products underneath in every row cutting off one place towards the right hand, so shall you have the value desired, let the decimal fraction given be 127·533378472 and let the value thereof in minutes and seconds be desired, this fraction being multiplyed by 6 the product is 32·002708332 from which cutting off one place of the fraction given, the figures remaining give 32 minutes, and so multiplying of the remainer by 6 continually, the products give 00 seconds, 09 thirds, and 45 fourths, almost as by the operation in the margent, doth appear.

127·533378472	2
	6
232·002708332	0
	6
00·016249992	0
	6
09·749995	2
	6
44·999712	

A table for the ſpeedy reducing of Engliſh money, and the parts of an ounce in *Troy* weight, into decimals, and the contrary.

L. M.	Pence	0	1	2	3
46	23	095833	096875	097916	098958
44	22	091666	092708	093750	094791
42	21	087500	088541	089583	526090
40	20	083333	084375	085416	086458
38	19	079166	080208	081250	082291
36	18	075000	076014	077083	078125
34	17	070833	071874	072916	073958
32	16	066666	067708	068750	069792
30	15	062500	063542	064583	065625
28	14	058333	059375	060416	061458
26	13	054166	055208	065250	057292
24	12	050000	051042	052083	053125
22	11	045833	046875	047016	048958
20	10	041666	042708	043750	044791
18	9	037500	038541	039583	040625
16	8	033333	034375	035416	036458
14	7	029166	030208	031250	032291
12	6	025000	026014	027083	028125
10	5	020833	021874	022916	023958
8	4	016666	017708	018750	019791
6	3	012500	013541	014583	015625
4	2	008333	009375	010416	011458
2	1	004166	005208	006250	007291
0	0	000000	001042	002083	003125

The

The use of the Table.

THis Table doth consist of six Columns, in the first, you have each other Grain in two penny weight *Troy*, in the second every penny in two shillings, in the other four Columns you have the decimals, answering to the grains in *Troy* weight, and to the pence and farthings not exceeding two shillings in English mony. Example, let the decimal 1 penny weight, and 16 grains, be required, or the decimal of 40 grains, I look for 40 grains in the first Column, and in the third, I find the decimal thereof to be 083333. Or let the decimal of 1 penny weight, and 11 grains be required, that is the decimal of 35 grains; 34 grains I find in the Table; and therefore in the same line in the first Column, I find 072916, for the decimal thereof; if the decimal of 17 penny weight and 13 grains were required, the decimal of 16 penny weight is the half thereof, *viz.* 8and that decimal of one penny weight 13 grains is 077083 and so the decimal required, is 8·077083, the like may be done for any other; and so for mony you have the pence in the second Column and the farthings in the top of that page, and in the angle of meeting the decimal answering thereunto, thus the decimal of 19 pence 3 farthings is 082291, and so for any other.

CHAP. XVI.

Of the Addition and Subtraction of Decimals.

1. THe eſſential numeration of decimal fractions, in all the four ſpecies, to wit of addition, Subtraction, Multiplication and Diviſion is the ſame as in whole numbers, only if the numbers given to be added, ſubtracted, multiplyed or divided, be any of them mixt numbers, that is one part of a whole number, and the other a decimal fraction, or that in the ſeveral operations, integers ſhall ariſe in the working, the greateſt difficulty is to diſtinguiſh the Integers from the Decimal parts, which yet in the three firſt Species of numeration is very eaſie, and in the fourth, not very hard to effect, as by example, will appear.

Let the Decimals of theſe ſeveral ſums of mony be given to be added together.

1					
10.	17.	08 ——	03 ——	10.	8864583
8.	12 ——	09 ——	02 ——	8.	6395833
6.	09 ——	11 ——	01 ——	6.	4968750
13.	19 ——	10 ——	02 ——	13.	9937590
40.	00.	04 ——	00	40.	0166666

Draw a downright line between the whole numbers and the Decimal fractions, and then add them

them as in whole numbers, ſo will the ſumm be 40l. 00s. 04 as by the operation doth appear.

2. The Subtraction of Decimals is as eaſie, only, as before, you are to diſtinguiſh the whole number from the fraction by a ſtroke or point, and then proceed as in whole numbers hath been directed.

	Example.			Decimals.
From	29 · 11	03	01	29·5635416
Deduct	14 · 19	11	02	14·9979166
Remain.	14 · 11	03	03	14·5656250

CHAP. XVII.

Of the Multiplication of Decimals.

1. THough the Multiplication of Decimals, doth not at all differ from the Multiplication of whole numbers, as to the manner of the work, and ſo I might be as brief in the explanation thereof, as in Addition and Subtraction; yet that the excellent uſe of decimal fractions may appear, I ſhall illuſtrate this Rule with more examples, than the former

2. And to diſtinguiſh the Integers, from the Decimal parts, when the Multiplication is finiſhed, conſider how many decimal parts there are in both numbers given, and cut off ſo many figures, or places from the product towards the right hand the reſt towards the left are, Inte-

gers, and if the whole product have not so many places, as there are parts in both the numbers given, you must prefix as many Cyphers before the product towards the left hand as there are places wanting, to make it even with the number of the places in the parts of both the numbers given.

Example, let 2 pound 9 shillings and 6 pence be given to be multiplyed, by 2 pound 9 shilling 6 pence, the Decimal of 9 shillings & 6 pence, is, .475, and therefore the Multiplicand is 2·475
And the Multiplicator also is 2·475

12375
17325
9900
4950

the product is —— 6·125625
that is, 6 pound 2 shillings 6 pence, and 625 parts.

2 Example.

Let a board in length be 14 feet 6 inches 3 quarters, and in breadth, 2 foot 9 inches 3 quarters, and let the content of that board be required: the Decimal answering to 6 inches 3 quarters, is 5625, and therefore the Multiplicand is 14·5625 and the Decimal of 9 inches 3 quarters is, 8125, and therefore the Multiplicator is 2·8125, which being multiplyed together, as whole numbers the

14·

145625
2·8125

728125
291250
145625
1165000
291250

Product is —— 40·95603125

that is, 40 feet 11 inches and 1 quarter of an inch, as it was before found in *Chap.* 10.

3. *Example.*

Let the Decimal ·3625
be given to be multiplied by ·2387

25375
29000
10875
7250

The product is —— 8652875

which having but seven places of figures, whereas there are eight places of parts in both the numbers given, I set a Cypher before the product towards the left hand to make them equal, and then the product is.08652875.

3. By these few examples the easie resolution of some questions by decimal fractions doth appear, which are any other way troublesome enough; and as to the manner of working, more needs

needs not be ſaid neither, but yet there are ſome contractions in Multiplication which are in aſtronomical queſtions very uſeful, and alſo in making of Tables of intereſt and ſuch like, which are ſet down by Mr. *Oughtred* in his *Clavis*, Chap. 4 It is to find any part of the product towards the left hand without finding the remainer thereof towards the right hand, as if 583614 were given to be multiplied by 472963 and that the ſix firſt figures of the product were required towards the left hand, without any conſideration had to the uſe of the figures of the product towards the right hand. The way is thus, ſet the figures of your Multiplicator under the figures of your Multiplicand, but the quite contrary way, as here you ſee.

Then beginning with the firſt figure towards the right hand I ſet down the product thereof as was directed in the multiplication of whole numbers, which done I multiply by the ſecond figure, but begin with that figure of the Multiplicand which ſtands directly over it, and ſet the product under the firſt figure of the firſt product, and ſo the reſt of the figures in the Multiplicator, having ſtill regard to that increaſe, which would ariſe out of the figure preceeding that with which you begin your Multiplication, ſo ſhall there be effected what was propounded, as by the operation doth appear; and for the clearer manifeſtation I have added the whole product alſo.

583614
369274
2334456
408529
11672
5252
349
17
27602 75

583614

583614
472963

2335456 | .
408529 | 8·
11972 | 28·
5252 | 526·
350 | 1684
17 | 50842

276027·81 28282

CHAP. XVIII.

Of the Division of Decimals.

1. THis is the last Species of essential numeration, and the most difficult, but not much more difficult in decimal fractions than in whole numbers; in the Arithmetick work there is no difference between them at all, that difference that is, between them and all the difficulty too, is in discovering the nature of the quotient, as whether it be only a fraction, or a mixt number, or which be integers and which fractions, or if fractions only whether the first place be tenths or hundreds, or of some other denomination.

2. For the resolving of this question in all the cases or varieties that can possibly happen, take this general rule.

The first figure in your quotient will be always

ways of the same degree or place with that figure or Cypher in your Dividend, which standeth over the place of unites in your Divisor.

To illustrate this rule, I will adde an example or two; let it be required to divide a mixt number by a mixt number, let the product of the first example in the last Chapter 6.125625 which is a mixt number, be given to be divided by the Multiplicator there given, which is a mixt number also, to wit, 2.475, division being made according to the rules given for the dividing of whole numbers, the figures in the quotient will be 2475. Now it remaineth to separate the integers in this quotient from the Decimal parts, to perform which I subscribe the Divisor 2·475 underneath the first dividual 6·125 and I find that the figure 2 which stands in the unites place in the Divisor, doth also stand under the place of unites in the Dividend, and therefore I conclude according to the rule given, that the first figure in the quotient must also stand in the first place of Integers, and consequently that the next place on the right hand must be the beginning of the fraction, and the note of separation mutt be put between 2 and 4, as here you see.

6·125625 (2·475
2·475

2. Example, let the mixt number 612·5625 be given to be divided by ·2475 the quotient will be 2475 as before, but placing the Divisor

visor under the Dividend, I find that the place of unites in the Divisor which is now supplied by a Cipher, doth stand

0612·5625 (2475
·2475

under the fourth place of Integers in the Dividend, and therefore the first figure in the quotient, is the fourth place of Integers also, and consequently in this example there are no decimal parts in the quotient.

3. Example, Suppose the Decimal ·3675 were given to be divided by this Decimal ·025 the quotient will be, 147, and to discover the nature thereof I set the Divisor under the Dividend thus

00·3675 (147
·025

from whence it appeareth that the unites place in that Divisor, is supposed to stand under the place of tens in the Dividend, and therefore there are two places of Integers in the quotient. And by these few examples, the use of the rule in any case is, I hope, sufficiently declared.

The benefit of Division by Decimals may partly appear by the following propositions.

1 Proposition, Let 8118 pounds 11 shillings 3 pence be given to be divided amongst 283 men, 11 shillings 3 pence being turned into a Decimal, the Dividend is 8118·5625 which being

ing divided by 283 the

```
283) 8118·5625 (28·6882
      566
     ----
      2458
      2264
      ----
       1945
       1698
       ----
        2476
        2264
        ----
         2322
         2264
         ----
          585
          566
          ---
           19
```

quotient is 28·6882 which being reduced is 28 pound 13 ſhillings 9 pence for each man,

2. Propoſition, In Aſtronomical fractions let 13 ſigns 19 degrees 36 minutes 32 ſeconds 47 thirds and 20 fourths be given, to be divided, by 17 degrees, 37 minutes, 25 ſeconds, theſe numbers being converted into Decimals ſtand thus.

409·61188588018	for the Dividend
17·6·236111111	for the Divisor

352472222222

1571396636581
528908333333

426883032488
352472222222

744108102660
704944444444

39163658216
35247222222

3916435994
3524722222 (2

391713772
352472222 (2

39241550
35247222 (2

3994328
3524722

569606
352472 (2

117134

And

And the quotient is and being reduced is 23 deg. 14 min. 32 sec. as by the operation doth appear, in which you may see not only the excellent use of decimal fractions, but an excellent contraction of common division; for as in Multiplication I shewed you how to shorten every particular product, so may you by considering the manner of this Division, see how to shorten your Divisor, and yet produce the same quotient, as would arise by using the Divisor at the whole length given.

23.242222
6
14)53332
6
31·9992

3. Proposition, If the content of a board be 40 feet 11 inches 1 quarter of an inch and 15 sixteenths of a quarter, and the breadth 2 foot 9 inches $\frac{3}{9}$, and let the length of that board be required.

The Decimal of 11 inches 1 quarter $\frac{15}{16}$ by the second example of the last Chapter is ·95703125. So that 40·59703125 is the Dividend, and 2·8125 is the Divisor, and the quotient is (14·5625

2·

```
2·8125)  40·95703125
         28125
         ------
         128720
         112500
         ------
          15820
          14062
          -----
           1757
           1687
           ----
             71
             56
             --
             15
             14
             --
```

Compare these examples with those in the 11 Chapter, and use that way which liketh you best.

CHAP. XIX.

Of the relation of numbers in Quantity.

1. HItherto we have ſpoken of ſingle Arithmetick, Comparative followeth; in which numbers are to be conſidered as they have relation to one another, in quantity or in quality.

2. Relation in quantity is of equal or unequal numbers; and hence it is called Relation of equal or unequal reaſon, in both which the numbers propounded are always two, the firſt of which is called the Antecedent, and the other the Conſequent.

3. Equal reaſon, is the Relation that equal numbers have to one another, as 5 to 5, 6 to 6, 12 to 12.

4. Unequal reaſon is the relation, that unequal numbers have to one another, and this is either of the greater to the leſs, or of the leſs unto the greater.

5. Unequal reaſon of the greater to the leſs, is when the greater number is the Antecedent, and the leſſer, the Conſequent, that is, when the greater number is firſt ſet down, and the leſſer after it, or when the greater number is ſet over the leſs, with a line between them in manner of a vulgar fraction, as of 6 to 3, 5 to 2, where 6 and 5 are Antecedents, 3 and 2 are Conſequents, and may be otherwiſe written thus $\frac{6}{3}$ $\frac{5}{2}$.

6. Unequal

6. Unequal reason of the lesser to the greater is when the lesser number is the antecedent, and the greater the consequent; as 5 to 6, 2 to 5.

7. The relation that these several kinds of numbers have to one another in quantity, is either in respect of the difference between the antecedent and the consequent, or in respect of the reason that is between them.

8. The difference between the antecedent and the consequent is found by subtracting the consequent from the antecedent; thus the difference between equal numbers as of the relation of 5 to 5, 6 to 6, or 12 to 12, is 0. but the difference of the relation of 6 to 3 is 3, of 5 to 2 is 3, for 3 deducted from 6, the remainer is 3, and 2 deducted from 5 is 3 also, but the difference of the relation of 3 to 6 and 2 to 5 is 3 less than nothing, that is the antecedent is less by 3 than the consequent.

9. The rate or reason between 2 numbers is found by dividing the antecedent by the consequent.

10. The rate or reason between two equal numbers is always an unite, for if it be demanded how often 5 is conteined in 5, the answer is 1.

11. The rate or reason between 2 unequal numbers is greater than unity, if the antecedent be the greater, and less than unity if the antecedent be the lesser number; thus the rate or reason of 8 to 5 is $1\frac{3}{5}$ but the rate, or reason of 5 to 8 is $\frac{5}{8}$.

12. Both these kinds of unequal reason are either simple or compound.

13. The simple kinds of unequal reason are

of three varieties. 1. Manifold, 2. Superparticular, 3. Superpartient.

14. Manifold ſimple reaſon, is when the greater number doth contain the leſs a certain number of times, without leaving any remainer, as 4 to 2, 9 to 3, 16 to 4 are numbers which have manifold reaſon, as double, triple, and fourfold reaſon, for the greater numbers being divided by the leſs, the quotients are 2. 3. 4.

15. Superparticular, is a ſimple rate or reaſon in which the greater number doth contein the leſſer once and one part more, as 3 to 2, 6 to 5, 8 to 7, in which the antecedent doth contein the conſequent once, and one part more of the conſequent, as by dividing the antecedents by the conſequents, the quotients clearly ſhew; to wit, $1\frac{1}{2}$, $1\frac{1}{5}$ $1\frac{1}{7}$. There is the ſame rate or reaſon in theſe 12 to 8, and 15 to 10, for though the quotients are $1\frac{4}{8}$, $1\frac{5}{10}$ yet being reduced, they are $1\frac{1}{2}$.

16. Superpartient, is a ſimple rate or reaſon in which the greater number doth contein the leſſer once, and ſeveral parts of the leſſer; as 5 to 3, 7 to 4, 13 to 8, in which the antecedents being divided by the conſequents, the quotients are $1\frac{2}{3}$, $1\frac{3}{4}$, $1\frac{5}{8}$.

17. The compounded kinds of unequal reaſon are either Manifold Superparticulars or Manifold Superpartient. That theſe are reaſons compounded of the preceding doth plainly appear by their very names, the one being the ſecond joyned unto the firſt, and the other the third joyned unto the firſt.

18. Manifold Superparticular reaſon, is a compounded

pounded reaſon, in which the greater number doth contein the leſſer divers times, and one part more of the leſſer; as in theſe unequal reaſons, 5 to 2, 10 to 3, 13 to 4, the greater numbers being divided by the leſſer the quotients are $2\frac{1}{2}$, $3\frac{1}{3}$, $3\frac{1}{4}$.

19. Manifold Superpartient reaſon, is a compounded reaſon, in which the greater number doth contein the leſſer ſeveral times, and ſeveral parts more of the leſſer, as in theſe unequal reaſons 11 to 4, 12 to 5, and 22 to 6, the greater numbers being divided by the leſſer, the quotients are, $2\frac{3}{4}$, $2\frac{2}{5}$, $3\frac{2}{3}$.

CHAP. XX.

Of the relation of numbers in Quality.

1. RElation of numbers in Quality, (otherwiſe called Proportion,) is either Arithmetical or Geometrical.

2. Arithmetical proportion, is a Relation that numbers have unto the equality of their differences; as in 8.7.6. and in 12.9.6.3 there are two proportions which have equal differences; in that firſt rank of numbers, the equal or common difference is 1, and in the ſecond 3.

3. Arithmetical proportion, is either continued or interrupted.

4. Arithmetical proportion continued, is when the ſame difference is continued from the

first numbers to the last, as in this rank of numbers. 5.7.9.11. the common difference is 2.

5. Arithmetical proportion interrupted, is when the difference between the first and second is the same with the third and fourth, but not between the second and third, or when the difference is discontinued in any part of the rank, as in these numbers, 10.8.4.2. the difference between 10 and 8 is 2, and the difference between 2 and 4 is 2, but the difference between 4 and 8 is 4.

6. In Arithmetical progression, two things may be inquired, either the terms that constitute the progression, or the sum that the terms in a certain progression made.

7. Sometimes all the terms in an Arithmetical progression at a certain given rate may be required to be expressed in their natural order; or the progression being interrupted, some particular term in that progression may be required.

8. If it be required to express the terms in any rate propounded, add the rate to any given term continually and you have what is required; as if it were required to make a rank of numbers, in Arithmetical proportion, answerable to the rate or difference that is between 1 and 5, add 4 which is the difference between the numbers given unto 5, and so continually to their sum and you shall constitute this rank of numbers 1.5.9. 13.17.21. which is the rank of numbers in Arithmetical proportion required.

9. If some particular term in any progression be required without the rest, deduct, from the term required, the remainer being multiplied by the

the common difference in that progreſſion, and the product added to the firſt ſhall give the term deſired: as in this progreſſion 4.7.10, let the 12 term from 4 the firſt term given be required, deducting one from 12 the remainer is 11, which being multiplied by 3 the common difference the product is 33, to which adding 4 the firſt term, the ſum is 37 for the 12 term required: and in like manner the 30 term wil be found to be 91: the like may be done for any other.

The Terms.	4	2	10	37	91
The number.	1	2	3	12	30

10. If the ſum of the terms in any rank of numbers, in Arithmetical proportion continued, multiply the ſum of the firſt and laſt terms by the number of the terms, half the product ſhall be the ſum required, as in this example, 1.5.9.13.17.21, the ſum of the firſt and laſt terms is 22, which being multiplied by 6 the number of the terms the product is 132, the half whereof is 66 the ſum of the terms required.

11. Three numbers being given which differ by Arithmetical proportion continued, the mean number being doubled, ſhall be equal to the ſum of the extreams, ſo 5. 9. 13. being given, the double of 9 is 18 and the ſum of 5 and 13 is 18 alſo.

12. Four numbers being given that differ by Arithmetical proportion continued or interrupted, the ſum of the two means ſhall be equal to

the ſum of the two extreams, ſo 5. 9. 13 17 being given, the ſum of 9 and 13 the two mean numbers, is equal to the ſum of 5 and 17 the 2 extreams.

13. Geometrical proportion is a relation that numbers have to the equality of their rate or reaſon: as in 2.6.4.12, where the rate between 2 and 6 is the ſame with that which is between 4 and 12; for as 6 is three times as much as 2, ſo 12 is three times as much as 4.

14. Geometrical proportion is either continued or interrupted.

15. Geometrical proportion continued, is when the ſame rate or reaſon is ſtill kept in the whole rank of numbers given, as 2. 4. 8. 16. 32, in which the progreſſion is continued by double reaſon, for as 4 is twice 2, ſo 8 is twice 4, 16 is twice 8, and 32 is twice 16.

16. In numbers that increaſe by Geometrical proportion continued, if you multiply the laſt term by the rate or reaſon by which the rank of numbers is created, and from the product ſubtract the firſt, the remainer being divided, by the rate leſs one ſhall give you in the quotient, the total ſum of all the terms. Example, let the rank of numbers propounded be 3. 9. 27. 81. 243, the rate or reaſon by which this rank of numbers is created is 3, by which the laſt term 243 being multiplied the product is 729, out of which deducting 3 the firſt term, the remainer is 726, which being divided by the triple leſs one that is by 2, the quotient gives me 363, for the ſum of the terms propounded.

17. Three

17. Three numbers being given which do increaſe by Geometrical proportion, the ſquare of the mean ſhall be equal to the product of the extreams; as 9. 27. 81. being propounded, the ſquare of 27 is 729, and the product of 81 by 9 the two extreams is 729 alſo.

18. Geometrical proportion interrupted, is when the rate or reaſon which is between the firſt and ſecond and between the third and fourth, is not to be found between the ſecond and third; as 6. 3. 16. 8. in which 3 is half 6, and 8 half of 16, but the ſame rate is not found between 3 and 16.

19. Four numbers being given which do increaſe by Geometrical progreſſion continued or interrupted, the product of the two mean numbers ſhall be equal to the product of the extreams: let the four numbers given be 6. 3. 16. 8. the product of 16 by 3 is 48, and the product of 8 by 6 the extream numbers is 48 alſo.

CHAP.

CHAP. XXI.

Of the Rule of Three.

THis Golden Rule doth from gi'n numbers three
Shew in Proportion what the fourth must be:
What makes the Queſt. muſt the third place poſſeſs;
Then ſee what it requires, be't more or leſs:
If more, you muſt by th' leſs extream divide,
If leſs, the greater muſt the Quote decide.

1. From the laſt rule of the preceeding chapter doth ariſe this precious Jewel in Arithmetick, which for its excellent uſe is called the Golden Rule, otherwiſe and more commonly the Rule of Three; becauſe it teacheth from three numbers given, how to find a fourth that is in Geometrical proportion to them.

2. This Rule of three is either ſimple or compound.

3. The ſingle Rule of three is, when three numbers are propounded, and a fourth in proportion to them is required.

4. This Rule of three is either direct or inverſe.

5. The

5. The rule of three Direct is when the third term hath such proportion unto the fourth, as the first hath to the second.

6. The Rule of three Inverse is, when the first term hath such proportion to the fourth, as the third hath to the second.

7. The difficulty of this Rule lieth in two things, first in stating the question or placing the numbers given, and then secondly in discovering, whether the first or third term must be the Divisor.

8. The question may be easily stated by considering, by which of the three numbers given the question is moved, for that must be always the third term, and that which is of the same denomination with the third, must be always set first, and the number remaining is to be set between them, and must be always of the same denomination with the fourth that is required.

9. The Question being stated, to discover whether the first or third number given must be the divisor, consider again whether the fourth term required, must be more or less than the second term given, for if it must be more, the lesser extream must be the divisor, but if less, the greater extream must be the divisor.

Example, If 12 men spend 36 pound, how much shall 18 men spend; here the question is concerning the 18 men, this is therefore the third number, and 12 men is the number of the same denomination, and must therefore possess the first place, and the middle number is 36 pounds: so that the numbers in the question must stand thus.

And

And now to diſcover whether the firſt or laſt of theſe numbers muſt be the Diviſor, I conſider again whether the fourth term required muſt be more or leſs than 36. the middle term or ſecond number, and my reaſon tells me that 18 men muſt needs ſpend more than 12, therefore the fourth number muſt be greater than the ſecond, and ſo 12 the leſſer extream muſt be the Diviſor; now then foraſmuch as the product of the two mean numbers is equal to the product of the two extreams by the laſt rule of the preceding chapter, it followeth that if I multiply 36 by 18 and divide the product by 12, the quotient will be the fourth term required, and ſo the anſwer will be found to be 54 pounds.

Men	lib.	Men	lib.
12	36	18	54

2. Example, If 25 ſhillings in Wine will ſerve 36 men when Wine is at 12 pounds the Tun, how many men will the ſame ſum ſerve, when Wine is at 18 pounds the Tun; Here the queſtion is concerning the 18 pounds for a Tun of Wine; this is therefore the third number, & 12 pounds the Tun is of the ſame denomination, and muſt therefore poſſeſs the firſt place, and the middle number is the 36 men, and ſo the numbers in the queſtion muſt ſtand thus.

lib.	Men	lib.
12	36	18.

And now to discover whether the first or third of these numbers must be the Divisor, I consider if the higher the price of Wine is, the fewer persons will 25 shillings serve, and therefore 18 the greater extream must be the Divisor, and then by the Rule of three inverse it is as 18.36.12.14. These two examples well considered will be sufficient to shew the nature of this Rule, and the manner of working: but because there is such variety of questions to be resolved thereby, in which sometimes one part of single Arithmetick is exercised, sometimes another, and of Comparative Arithmetick also, by way of preparation for the better stating of the question, and more plain and easy solution, it will not be amiss to add an example in each variety, or in so many of them as are of daily practice.

3. My first instance shall be in such questions, in which the addition of whole numbers is required in order to the better stating and resolving of them by this Rule.

A Merchant buyes 120 Tun of Wine for 2400l. and the fraight thereof from *Spain* to *London* cost him 1200l. for loading and unloading 30l. for custom 50l. and for expences in the voyage 64l. and he designs to get 800l. by the bargain. The question is at what rate this wine must be sold per Tun.

In such examples, the price of the fraight with all

all the expences and gain muſt by addition be brought into one ſum, which in this particular is 4544; then I ſay if 120 Tun coſt 4544 pound, what ſhall 1 Tun coſt, and the anſwer is 37 $\frac{104}{120}$ or $\frac{13}{15}$ or $\frac{26}{30}$ or $\frac{13}{15}$ of a pound.

4. Sometimes a queſtion belonging to the Rule of three is prepared for ſolution by ſubtraction, as in this following. If 24 Gallons of water do in one hours time run from one pipe into a Ciſtern conteining 250 Gallons, and run out 16 Gallons by another in the ſame time, in how many hours will that Ciſtern be filled.

Here one of the terms propounded, muſt be explained by ſubtraction, for it is plain that the enquiry is, by how much the Ciſtern doth fill more than it empties; if therefore you ſubtract 16 Gallons from 24 the remainer is 8 Gallons, which the Ciſtern recieves in an hours time; hence the queſtion muſt be thus ſtated.

If a Ciſtern recieve 8 Gallons in one hours time, in how many hours will it receive 250 Gallons: facit, 32 $\frac{1}{2}$.

5. Sometimes a queſtion belonging to this rule muſt be prepared by addition and ſubtraction both, as in this following. A Merchant buyes 4 bags of Pepper.

The

			lib.		
The first marked	A	containing	85	tare	05
The second marked	B	containing	76	tare	05
The third	C	containing	98	tare	12
The fourth	D	containing	75	tare	05
			335		028

And he is to pay 35 shillings *per Cent.* neat. The question is how much the 4 bags cost.

In the Trade of Merchandize, there are certain allowances and abatements used, which are known by the names of Tare and Tret, by Tare they understand the weight of the chest, bag, but, &c. And by Tret the overweight which is allowed the buyer, in this question we have to do with the former only; where first you must get the gross weight of all the parcels by addition and they are 335 lib. and also the sum of the allowances for the Tare which is 28 lib. then deducting the 28 lib. Tare from 335 gross weight, the remainer is 307 lib. neat; hence the question must be stated thus.

If 100 pound cost 35 shillings what shall 307 lib. cost: facit 107 $\frac{1}{20}$.

6. Sometimes a question belonging to this Rule must be prepared for solution by Multiplication, as in this following. How many *Spanish* Pistolets at 14 shillings sterling the piece, ought to be received for 128 *Escus* d'or, at 7 shillings sterling the piece. Here the 128 *Escus* d'or must be reduced into English by multiplying them by 7 shillings, the value of one *Escu* d'or, whose product

duct is 896 ſhillings, and then the queſtion muſt be thus ſtated.

If 14 ſhillings be worth 1 Piſtolet, how many Piſtolets are 896 worth. Facit 64 Piſtolets.

7. Sometimes a queſtion belonging to this rule muſt be prepared for ſolution by multiplication and addition, ſometimes by multiplication and ſubtraction; as in theſe examples following, the firſt of which requireth multiplication and addition.

A Butcher ſends his man with 216 pound ſterling to buy Cattel, Oxen at 11 pound apiece, Cows at 2 pound a piece, Colts at one pound 5 ſhillings, Hogs at 1 pound 15 ſhillings a peice, and of each a like number, the queſtion is how many of each he might buy for that mony. To reſolve this queſtion I muſt firſt reduce the pounds ſterling into ſhillings by multiplication, and 216 pound being multiplied by 20 the product is 4320 ſhillings, and the ſeveral prizes of the Cattel muſt be reduced into ſhillings alſo, and thus 11 pounds for an Ox is 220 ſhillings, the price of a Cow is 40 ſhillings, the price of a Colt 25 ſhillings, and the price of a Hog is 35 ſhillings, the ſum of theſe ſeveral prizes is 320 ſhillings, this done the queſtion may be thus ſtated.

If 320 ſhillings buy 1 of each ſort, how many ſhall 4160 buy, facit 13.

2. Example, In the which the queſtion is to be prepared by multiplication and ſubtraction.

If 128 Gallons of water run into a Ciſtern in an hours time from one Cock, and 174 Gallons of water run into another Ciſtern, in an hours time alſo,

alſo, but not begin to run till 4 hours after the firſt, in what time will the quantity of water run out of both be equal? To reſolve this queſtion, one of the terms given muſt be prepared by Multiplication, and another by Subtraction; firſt there muſt be computed how much water was run out of the firſt Cock before the ſecond began, and that is 4 times 128 Gallons that is 512: ſecondly it muſt be conſidered, how many Gallons more doth run out of the laſt Cock than doth out of the firſt in an hours time, which by ſubtracting 128 from 174 I find to be 46, and hence this queſtion is to be thus ſtated.

If I gain 46 Gallons in one hour, in how many hours ſhall I gain 512 Gallons. Facit 11 $\frac{1}{46}$.

8. Sometimes a queſtion belonging to this rule, muſt be prepared for ſolution, by Arithmetical or Geometrical proportion, as in theſe queſtions following.

A man going a journey ſpends one ſhilling the firſt day, 3 the ſecond, 5 the third, 7 the fourth, ſtill encreaſing his expences by this proportion till he hath ſpent 1500 ſhillings, I demand in how many days that ſum is ſpent.

To reſolve this queſtion the ſum of ſuch an Arithmetical progreſſion for ſome certain time muſt be firſt computed, as ſuppoſe for thirty days, which will be found to be 900 ſhillings, and hence it may be thus concluded.

If 900 ſhillings laſt me 30 days, how long ſhall 1500 ſhillings laſt me. Facit 50.

Another queſtion may be this, If a piece of Cloth containing 40 yards did coſt me 50 pounds,

at what rate muſt that Cloth be ſold to gain 12 pound in the hundred?

Before this queſtion can be reſolved, I muſt find the price of one Yard, by a proportion Geometrical by way of preparation thus, If 40 Yards coſt 50 pound, what ſhall one Yard coſt, facit $1\frac{1}{4}$. Then I ſay.

If 100 pounds be increaſed to 112, to what ſhall $1\frac{1}{4}$ be increaſed? Anſwer $1\frac{2}{5}$.

CHAP. XXII.

The Rule of Three in fractions.

1. FRactions as I have already ſhewed, are of 3 ſorts, *viz.* ſuch as are many times expreſſed like integers, ſuch as are expreſſed by their numerators and denominators, and ſuch as have a unite with Cyphers annexed for their denominator, and now known by the name of Decimal fractions: in each of theſe I will exemplify this Rule by ſome few examples; and firſt in ſuch fractions as are expreſſed like Integers.

2. Your queſtion being ſtated bring your numbers propounded into the leaſt name mentioned, or as low as you deſire the queſtion to be anſwered in, then multiply the ſecond and third and divide the product by the firſt, if your queſtion belong to the Rule of Three direct; or multiply the firſt and ſecond and divide by the third,

if

if it belong to the Rule of Three inverſe, the quotient being reduced ſhall be the anſwer required.

Example.

If 7 lib. 8 ounces of Currants, coſt 25 .7d. what ſhall 100 $\frac{1}{2}$ 13 lib. coſt. In this queſtion the firſt and third terms muſt be reduced into ounces, and the ſecond term into pence, and then the queſtion will ſtand thus.

If 112 ounces Coſt 31 pence, what ſhall 1267 ounces coſt. Facit 359d. 1 $\frac{44}{112}$ farthings; that is 1l. 9s. 11d. 1f. $\frac{3}{7}$ of a farthing.

A ſecond example may be this; A man doth borrow of his friend 246 lib. 7 ſhillings and 6 pence for 27 weeks, for how long time muſt he lend his friend 329 lib. 13 ſhillings 4d. to requite his kindneſs. Here it is plain that the fourth term required, muſt be leſs than the ſecond term given, and therefore the greater extream muſt be the Diviſor, and the numbers being reduced and placed as hath been directed they will ſtand thus 79130 —— 187 —— 79120. in which the greater extream being in the third place doth plainly ſhew that this queſtion doth belong to the Rule of Three inverſe, and therefore as

lib. 4821
59130 —— 189 days: 79120 lib. 128 ——
7912

3 Example in Sexagenary numbers, If 48 firſts, 28 ſeconds, give 60 minutes, what ſhall 25 minutes, 12 ſeconds give. According to the former Rules given in Multiplication 25 firſts, 12 ſeconds being multiplied by 60 minutes, the product is 25 degrees, 12 firſts, 00 ſeconds, which being divided by 48 firſts, 28 ſeconds the quotient will be 31 firſts, 08 ſeconds.

4. Example, in vulgar fractions. If $\frac{3}{7}$ of a Yard of Velvet be ſold for $\frac{4}{5}$ of a pound ſterling, what ſhall $\frac{4}{7}$ of a Yard coſt?

If reſpect be had to the Rules of the Multiplication and Diviſion of fractions already delivered in the 14th Chapter, the working of this Rule in fractions will be the ſame as in whole numbers; thus $\frac{4}{5}$ and $\frac{4}{7}$ being multiplied together the product will be $\frac{16}{35}$ which being divided by $\frac{3}{7}$ $\frac{3}{7}$ the quotient is $\frac{84}{105}$ or 1 lib. $\frac{4}{20}$ or $\frac{1}{20}$; and ſo the anſwer is 1 pound and one ſhilling.

Otherwiſe thus, Multiply the Denominator of the firſt number by the numerators of the ſecond and third continually, ſo ſhall the laſt product be a new numerator; then multiply the numerator of the firſt number by the denominators of the ſecond and third numbers continually, ſo ſhall the laſt product be a new denominator, and this fraction ſhall be the quotient deſired. Thus the denominator 3 being multiplied firſt by

by 4 and then by 7 the laſt product is 84; and the numerator 2 being multiplied firſt by 5 and then by 8 the laſt product will be 80 for a new denominator, and ſo the new fraction will be $\frac{84}{80}$ as before.

5 Example, If $4\frac{1}{4}$ of a Yard of Cloth in length, being 1 Yard and half broad, will make a Cloak, how much Pluſh that is $\frac{3}{4}$ of a Yard in breadth will ſerve to line that Cloak. Here the fourth term required muſt be greater than the ſecond term given, and therefore the leſſer extream muſt be the Diviſor, and the leſs extream being in the third place, plainly ſheweth, that this queſtion doth belong to the Rule of Three inverſe, and the numbers muſt ſtand as here you ſee.

breadth		length		breadth
	$1\frac{1}{2}$		$4\frac{1}{4}$	$\frac{3}{4}$
or	$\frac{3}{2}$		$\frac{17}{4}$	$\frac{3}{4}$

And $\frac{3}{4}$ being the Diviſor, 4 being multiplied firſt by 17 and then by 3 the laſt product is 204, and 3 being multiplied by 4 and by 2, the laſt product is 24, and ſo the new fraction or quotient ſought is $\frac{204}{24}$, which being reduced, is $8\frac{1}{2}$ yards.

6. Example, in Decimal fractions. If 7 ounces

4. Of a certain number of ſhillings and pence.

5. Of a certain number of pounds, ſhillings and pence with the parts of a penny.

3. Now for the reſolution of ſuch queſtions which may or do fall under any of theſe caſes; it is neceſſary that the Aliquot parts of a pound and ſhilling be firſt known, that is, how often the ſhillings or pence, which are the given price of one Integer are conteined in a pound or ſhilling, without leaving any remainer; thus 4 ſhillings is an aliquot part of a pound or 20 ſhillings, becauſe 4 may be taken 5 times in 20, without either exceſs or defect; and 3 is an aliquot part of a ſhilling or 12 pence, for 4 times 3 make 12; but 7 is not the aliquot part of 20, for two times 7 is leſs than 20; and 3 times 7 is more. In like manner 5 is not the aliquot part of 12, for 2 times 5 is but 10, and 3 times 5 is 15, the one wants of 12, and the other exceeds it; but yet any number of ſhillings under 20 may be reduced to the aliquot parts of a pound, and any number of pence under 12 may be reduced to the aliquot parts of a ſhilling.

Thus 7 ſhillings is one fift more, 3 twenties of a pound: and 5 pence, is one third more, one twelveth of a ſhilling, or one fourth, more one ſixth. Such aliquot parts of a pound or ſhilling as are moſt uſeful in the reſolution of queſtions of this nature, are here expreſſed in two Tables; with which I have joyned a third, ſhewing the product of 12 by any number not exceeding it ſelf

ſelf, which in many queſtions will be found as uſeful as either of the other.

Aliquot parts of a pound.	Aliquot parts of a Shilling.	The product of 12 by any number leſs by 1
	Pence.	
10 0	11	2 24
6 8	10	3 36
5 0	9	4 48
4 0	8	5 60
	7	6 72
	6	7 x 12. 84
	5	8 96
	4	9 108
	3	10 120
	2	11 132
	1	12 144

[redacted]gs premiſed, I will now ſhew how [redacted]n coming under the aforeſaid five ca[redacted]y be reſolved.

1. *Caſe, where the price of an Integer is ſhillings only.*

4. Where the price of 1, or an Integer is two ſhillings, the price of as many Integers as you will may be diſcovered by bare inſpection, for two ſhillings being the tenth of a pound, the double of the firſt figure (towards the right hand) is

ces 3 penny weight and 12 grains be worth 21l. 11s. 6d. what is the value of $1\frac{1}{5}$ ounce?

The Decimal of 3 penny weight is	0.15
And the Decimal of 12 ounces is	0.025
And the sum of these 2 Decimals is	0.515
Wherefore the first number in the Rule of Three is	7.175
Again the Decimal of 10s.6d. is	0525
Wherefore the second number is	21.515
And the third number is	1.5

Now to resolve this question, the 3 given numbers will stand thus. 7.175 — 21.525 — 1.5.

Lastly, multiplying the second by the third, the product is 32.2875 which being divided by 7.175 the quotient is 4.5 that is 4 pounds and ten shillings, which is the price of an ounce and half of that Gold.

CHAP.

CHAP. XXIII.

Of the Rules of Practice.

1. WHen the Rule of Three direct hath 1, or an Integer for the first term, it is commonly called a Rule of practice, not only for the speedy, but the practical resolution of such questions: for whereas other questions belonging to this Rule, do for the most part require Multiplication and Division, these in the ordinary way are resolved by Multiplication; and whereas Multiplication is generally much easier than Division, these questions are in an accustomary or practical way, for the most part performed by Division, and yet done with more ease than they can be by Multiplication: nay where Multiplication and Division are both used, the resolution is yet easier, than it is or can be by Multiplication only.

2. The questions to be resolved by these abbreviations of the Rule of Three, or practical operations, do for the most part come under one or other of these five cases. The price of 1 or an Integer doth consist either

1. Of a certain number of shillings under twenty.
2. Of a certain number of pounds and shillings.
3. Of a certain number of pence under twelve.

4. Of a certain number of ſhillings and pence.

5. Of a certain number of pounds, ſhillings and pence with the parts of a penny.

3. Now for the reſolution of ſuch queſtions which may or do fall under any of theſe caſes; it is neceſſary that the Aliquot parts of a pound and ſhilling be firſt known, that is, how often the ſhillings or pence, which are the given price of one Integer are conteined in a pound or ſhilling, without leaving any remainer; thus 4 ſhillings is an aliquot part of a pound or 20 ſhillings, becauſe 4 may be taken 5 times in 20, without either exceſs or defect; and 3 is an aliquot part of a ſhilling or 12 pence, for 4 times 3 doth make 12; but 7 is not the aliquot part of 20, for two times 7 is leſs than 20; and 3 times 7 is more. In like manner 5 is not the aliquot part of 12, for 2 times 5 is but 10, and 3 times 5 is 15, the one wants of 12, and the other exceeds it; but yet any number of ſhillings under 20 may be reduced to the aliquot parts of a pound, and any number of pence under 12 may be reduced to the aliquot parts of a ſhilling.

Thus 7 ſhillings is one fift more, 3 twenties of a pound: and 5 pence, is one third more, one twelveth of a ſhilling, or one fourth, more one ſixth. Such aliquot parts of a pound or ſhilling as are moſt uſeful in the reſolution of queſtions of this nature, are here expreſſed in two Tables; with which I have joyned a third, ſhewing the product of 12 by any number not exceeding it

ſelf, which in many queſtions will be found as uſeful as either of the other.

Aliquot parts of a pound.		Aliquot parts of a Shilling.		The product of 12 by any number leſs.	
		Pence.			
10	0	11		2	24
6	8	10		3	36
5	0	9		4	48
4	0	8		5	60
3	4	7		6	72
2	6	6		7 × 12.	84
2	0	5		8	96
1	8	4		9	108
1	4	3		10	120
1	3	2		11	132
1	0	1		12	144
Shil.	Pence.	1			

Theſe things premiſed, I will now ſhew how any queſtion coming under the aforeſaid five caſes may be reſolved.

1. *Caſe, where the price of an Integer is ſhillings only.*

4. Where the price of 1, or an Integer is two ſhillings, the price of as many Integers as you will may be diſcovered by bare inſpection, for two ſhillings being the tenth of a pound, the double of the firſt figure (towards the right hand) is

is the number of ſhillings required, and the reſt of the figures are ſo many pounds. Example, 567 yards at 2 ſhillings the Yard will coſt 56 pounds 14 ſhillings; for the double of 7 is 14 which I write down by it ſelf as ſhillings, then taking the reſt of the figures towards the left hand for pounds, the anſwer is 56l. 14s.

5. When the given price of 1 or an Integer is an even number of ſhillings greater than two, multiply the number of Integers whoſe price is required, by half the number of ſhillings given; the double of the firſt figure towards the right hand in the product being ſet down for the ſhillings apart, all the other figures towards the left hand ſhall be the pounds required.

Example, let the price of 365 Yards be required, at 14 ſhillings *per* 1 Yard: if you multiply 365 by 7 (which is the half of 14 the number of ſhillings given) the product will be 2562, now the double of 2, the firſt figure towards the right hand is 4, the other figures are 256 pounds, and ſo the anſwer is 256l -- 4s.

y.	s.	y.
1.	14	365
		7
		256.2

Here note that 4 ſhillings being the 5th part of a pound, if that be the price of an Integer, it will be all one to multiply by 2 or divide by 5, if the double of the firſt figure in the product towards the right hand be taken for the ſhillings according to this rule.

6. When the given price of 1 or an Integer is an odd number of ſhillings, for the odd ſhilling take

take the $\frac{1}{20}$ of the price propounded, and add it to the product of the price given by half the number of ſhillings remainer, taking the double of the laſt figure of the products for ſhillings according to the former directions, their ſum ſhall be the anſwer required. Example, let the price of 367 Yards be required at 9 ſhillings the Yard. The twentieth part of 367 is 18 pound 7 ſhillings, and the product of 367 by 4 (half the number of the ſhillings remaining) is 1468 that is 146 pound 16 ſhillings, which being added to 181. 7 ſhillings, the anſwer is 165 pound, 3 ſhillings.

y.	s.	y.
1.	9.	367
		4
20·367 ——		18 7
1468 ——		146 16
		165 03

Note, When 5 ſhillings is the given price of an Integer the ſhorteſt way will be to divide the number whoſe price is required by 4, becauſe 4 is the firſt part of a pound; thus if the worth or price of 367 Yards at 5 ſhillings the Yard were required, the anſwer would be $91\frac{3}{4}$ that is 91l. 15s.

2. *Caſe, Where the price of an Integer is pounds and ſhillings.*

7. When the price of 1 or an Integer doth conſiſt of pounds and ſhillings; firſt multiply the number of Integers whoſe price is required, by the number of pounds in the price given, and ſubſcribe the product as pounds; then proceed with the ſhillings in the price propounded, according

cording to the 5 or 6 rules of this Chapter, and ſubſcribe the ſum or ſums ſo found under the number of pounds, the total of theſe ſums ſhall be the anſwer required. Example, let the price of 1238 hundred weight at 3l. 12s. *per C.* be required, 1238 being multiplied by 3 the product is 3714, and the product thereof by 6 is 7428 that is 742l. 16s. and the twentieth part of 1238 is 619l. 18s. the which ſeveral ſums being added together their total 5067l. 14s. is the anſwer ſought.

C	l	s	
1.	2.	13.	1238
			3714
			742.16
			619.18
			5067.14.

3. *Caſe, Where the price of an Integer is a number of pence under* 12.

8. When the given price of 1 or an Integer is ſuch a number of pence, as is an Aliquot part of a ſhilling; divide the number of integers, whoſe value is required, by ſuch aliquot part; ſo will the quotient be the number of ſhillings, which anſwers the queſtion, and may be reduced into pounds (if need require) by dividing the ſame by 20.

Example, Let the value of 3947 pounds weight, be required at 3 pence the pound, be-

cauſe

cauſe 3 is the 4 part of 12 pence, I divide 3947 by 4 and the quotient is 986¾ that is 986 ſhillings 9 pence, or the ſhillings being divided by 20 the anſwer is 49l. 6s. 9d.

lib.	d	lib.
1.	3.	3947
	20.	986¾
		49.6.9

9. When the given price of 1 or an Integer is compoſed of aliquot parts of a ſhilling, divide the number of Integers whoſe price is required, by the ſeveral parts of which the given price of one Integer is compoſed; the ſeveral quotients being added together, ſhall be the value or ſum inquired.

Example, let the price of 1638 Yards at 7 pence the Yard be inquired; for as much 7 is compoſed of one third, and one fourth of a ſhilling, if I divide 1638, by 4 which is one third of a ſhilling, the quotient will be 402 ¾ ſhillings, again dividing 1638 by 3 which is the fourth of a ſhilling, the quotient will be 546 ſhillings, and the ſum of theſe two quotients 948¾ is the anſwer to the queſtion, or 94l. 16s. 6d.

y		
1. 7.	1638	
		d
4)	402	6
3)	546	0
	s	
	948	6
or	94	16 6

4. *Caſe,*

4. Case, Where the price of an Integer is a number of shillings and pence.

10. When the given price of an Integer consists of shillings and pence, multiply the number of integers, whose value is required, by the number of shillings given, and set down the product as shillings; then divide the said number of Integers, by the Aliquot parts of a shilling of which the pence are composed, and set their quotients under the former product; the sum of the product and quotients shall be the answer sought.

Example, let the value of 836 Yards at 17 shillings 9 pence the yard be required, the product of 836 by 17 is 14212, that is the product by 7 is 5852 and the product by 10, 8360, then dividing 836 by 2 and 4 severally the quotients are 418, and 209, and the sum of all is 14839 that is 741l. 19s.

y	s	d	y
1	17	9	836
17	4836	{	5852
		{	8360
	2) 836		418
	4) 836		209
	20)		14839
			741l. 19s.

11. When the given price of an Integer consists of shillings and pence, and that such shillings and pence considered together do make the aliquot part of a pound; the question may sometimes be more expeditiously answered, if we divide the number of Integers whose value is required, by such aliquot part of a pound, than by the former rule. Example, let the price of one integer be 6 shillings 8 pence, which is the third part of

of a pound, and let the value of 983 Yards at that rate be required: the product of 983 by 6 is 5898, and 983 being divided by 3 twice, because 4 pence is the third of a shilling, the quotient is 327 $\frac{2}{3}$ that is 327 shillings 8 pence, which being set down twice, the sum of the product and quotients 6553 shillings 4 pence, and this being divided by 20, the value of 983 Yards will be 327l. 13s. 4d. But now if you divide 983 by 3, the quotient is 327 $\frac{2}{3}$ that is 327 lib. 13 shillings 4 pence, as before.

y	s	d		
1	6	8	983	
6	983		5898	
3)	983		327	08
3)	983		327	8
20)			6553	4
			327	13 4

5. *Case, Where the price of an Integer doth consist of pounds, shillings and pence, and the parts of a penny.*

12. Where the given price of an Integer doth consist of pounds, shillings and pence; and the price of a certain number of Integers less than 10 be required; multiply the given price of one Integer, by the number of Integers whose value is desired, as hath been shewed in the Multiplication of pounds, shillings and pence; so shall the product be the answer required.

Example, let the price of 8 hundred weight be required, one hundred being 4lib. 17 shillings 9 pence, first I multiply 9 pence by 8 and they make 72 pence or 6 shillings; therefore I set down 0 pence and

and carry 6 to the next denomination: then I multiply 17 shillings by 8 and the product is 136, to which I add the 6 I carried and then the product is 142 that is 7 pound 2 shillings, therefore I set down 2 shillings and carry 7 to the pounds: then I multiply 4 lib. by 8 and they make 32, and the 7 I carried makes 39, and so the whole product is 39 lib. 2 shillings, 0 pence, as by the work appeareth: and so much is the value of 8 C. Weight; as was required.

lib.	shil.	pence
4	17	9
		8
39	2	0

13. When the given price of an Integer doth consist of pounds, shillings and pence; and the price of a certain number of integers more than 10 is required; reduce the pounds into shillings and add the shillings in the given price to them; then proceed according to the tenth rule of this Chapter.

Example, let the price of one hundred weight be 5 lib. 18 shilling and 4 pence, and let the price of 543 be required; the pounds and shillings being reduced to one denomination are 118 shillings; now therefore I multiply 543 by 118, & the product is 64074; and then because 4 is the third part of a shilling I divide 543 by 3 and the quotient is 181 shillings; which being added to 64074 the whole number of shillings is 60255, which being divided by 20 the quotient is 3212 lib. 15 shillings, 0 pence, which is the price required.

C	lib.	s	d	
1	5	18	4	543

118 x 543

4344
543
543

3) 543

64074
181

20)
Answer 64255
3212 lib. 15 shil.

14. When the given price of an integer doth consist of pounds, shillings and pence, with the parts of a penny, reduce the pounds into shillings, as in the last example; and for the pence and parts of a penny, work by the aliquot parts of a shilling, contained in the pence, except 1 penny, and the parts annexed in the question, if the parts of a penny be 2 farthings or more; but if it be but one farthing proceed with the whole numbers of pence as in the former examples; and for the farthing take one fourth of the number whose value is inquired, the quotient divided by 12 will be the shillings and pence desired; if 2 farthings be annexed to the pence they are with the penny not computed the eight part of a shilling; if 3 farthings you must for the odd farthing take the sixth part of the last quotient; all these quotients added together shall be the price required.

Example, let the price of one hundred weight

be, 3 lib. 15 ſhillings $7\frac{1}{4}$, and let the price of 95 C. be required. The pounds and ſhillings being reduced unto one denomination do make 75 ſhillings: by which if you multiply 95 the product will be 7125, and 95 divided by 4 and 3 ſeverally,

C	lib.	s.	d.	C
1.	3	15	$7\frac{1}{4}$	95
		475		
75 × 95		665.		
		7125	d	
4) 95		43	9	
3) 95		31	8	
		3	7	$\frac{1}{4}$
$\frac{1}{4}$ 95				
$\frac{1}{12}$) $49\frac{1}{4}$		7204	0	$\frac{1}{4}$
20)		360.	4. 0.	$\frac{1}{4}$

the quotients are 43 ſhillings, 9 pence, and 31 ſhillings, 8 pence, and 95 divided by four for one fourth of a penny, the quotient is 43 pence 3 farthings, which being divided by 12 the quotient is 3 ſhillings and 7 pence 3 farthings, which ſeveral quotients being added to the former product, the total is 7204 ſhillings 0 pence 3 farthings, and this again divided by 20 gives the anſwer to the queſtion, 360 lib. 4 ſhillings 0 pence 3 farthings.

2. *Example.*

2. *Example.*

C.	lib.	s.	d.	
1	6	17	$5\frac{3}{4}$	175
137	175	1225		
		525		
		175		
		23975		
			d	
3) 175		58	4	
8) 175		21	7	
d				
6) 21 7		3	$7\frac{1}{4}$	
20)	24058	6	$\frac{1}{2}$	
Answer	1202	18	6	$\frac{1}{4}$

15. When the given price of an Integer is given, and the price of many Integers of the same name, together with one fourth, one half, or 3 fourths of an Integer is required, the value of those Integers may be first found by some of the precedent rules, and then for the half of an Integer take the half of the given price, for one fourth of an Integer take one fourth of the given price, and for 3 fourths of an Integer, take the sum of one half and one fourth of the given price. Example, let it be required to know what 127 hundred weight, 3 quarters, 24 pound will cost at

4l. 17s. 7d. $\frac{3}{4}$ *per Cent.* The answer by the following operation will be 625 lib. 5 shillings 4 pence 2 farthings, and somewhat more.

C.	lib.	s.	d.	C.	q.	lib.
1	4	17	$8\frac{3}{4}$	127	3	24

97 x 127		889	
		1143	
		12319	d
3)	127	42	4
4)	127	31	9
8)	127	15	$10\frac{1}{2}$
6)	15 $10\frac{1}{2}$	2	$7\frac{1}{2}$

$\frac{1}{2}$ C	12411.	$2\frac{1}{2}$ more $\frac{1}{2}$ of $\frac{1}{4}$
$\frac{1}{2}$ C		48.$10\frac{1}{4}$ and $\frac{1}{2}$ of $\frac{1}{4}$
$\frac{1}{4}$ C		24.50 and $\frac{1}{2}$ of $\frac{1}{4}$
14 lib.		12.$2\frac{1}{2}$
7 lib.		6.$10\frac{1}{2}$ of $\frac{1}{4}$
3 lib.		2.7.

			lib.	s.	d.
20)	12505	$4\frac{1}{2}$	(625	5	$4\frac{1}{2}$

Where you may observe the price of 127 C. to be found after the manner of former examples, and the 3 quarters is the sum of one half and one fourth of the given price; then for the 24 lib. I take first the half 1 quarter of C. for 14 thereof; and the half of that for 7 pound more thereof, and for the 3 pound remaining I take $\frac{1}{7}$ of the price of

7

7 pound, thus: the price of 7 lib. is 6 shillings and a penny and something more; or 73 pence, which being multiplied by 3, the product is 219, which being divided by 7, the quotient is 31 $\frac{2}{7}$ that is 2 shillings 7 pence and $\frac{2}{7}$ of a penny. And hence it is apparent, that in resolving of questions after this practical way, some error will be committed, yet the loss for the most part will be less than a farthing, which is not considerable.

16. When the price of one pound weight is known, and the price of one hundred is required (that is 112) there is a rule differing from all the former, and somewhat more expeditious by which the value thereof may be discovered, and it is this: Twice so many shillings as there are farthings and once so many Groats in the price of one pound is the value of 1 C. weight. Example, let the price of one pound be 3 pence or 12 farthings,

	lib.		
Twice 12 shillings is		24s	
Once 12 groats is		4s. 8	
The Total is	1	8	0

The proof is plain. 1 lib. 12 far. 112 1344 in which there are 336 pence, that is 28 shillings.

17. By all the preceding rules, the price of one Integer being given, I have shewed how the price or value of any certain number of Integers may be found at that rate; but for as much as the converse of this is no less necessary to be known, I will now shew how from the known price of many Integers, to find the price or value of one.

If 123 Ells coſt 61 lib. 17 ſhillings, 6 pence, what is the price of 1 Ell: Reduce the pounds and ſhillings into ſhillings & divide by 123, the quotient ſhall be the anſwer to the queſtion; thus 61 lib. 17 ſhillings being reduced do make 1237 ſhillings, which being divided by 123 the quotient is 10 ſhillings, and 7 remains, which being reduced into pence is 84, which with the 6 pence in the queſtion do make 90 juſt, which being leſs than the diviſor I reduce into farthings and they make 360, which being divided by 123 the quotient is 2 farthings 9268 parts of a farthing, as by the work appeareth.

lib.

lib. s. d. s. d. f.

123. 61. 17. 6. 1. (10. 00. 2. 9268

20

1220

17

1237

123

07

12

84

6

90

4

360

246

1140

1107

330

246

840

738

1020

984

36

But if the first term be 100, the question will be answered by Reduction only, as if 100 Ells cost 74, 13.9d. what is the price of 1 Ell?

	lib.	s.	d.		s.	d.	far.
100	74	13	9	1	(14	11	1
	20						
	1480						
	13						
	14)93						
	12						
	186						
	939						
	11)25						
	4						
	100						

18. In the Rule of Three direct or inverse, when the Divisor with either of the other two given numbers may be severally divided, by some common measure, without leaving any remainer, the quotients may be taken for new terms, and proceeding in like manner as often as is possible, the operation will be much contracted.

Example, If 25 Yards, cost 75 pound, what shall 85 Yards cost?

y.		
25	75	83
5	15	83
1	3	83 (249

Another Example, if 27 men will finiſh a work in 25 days, in how many days will 15 men finiſh the ſame work? Anſwer in 45 days.

men	days	
27	25	15
9	25	5
9	5	1 (45

In the firſt rank you may obſerve, that the Diviſor 15 (for the rule is inverſe) and the firſt term 27 being ſeverally divided by their common meaſure 3, the three new terms (in the ſecond rank) will be 9. 25. 5. Again in the ſecond rank, the Diviſor 5 and the ſecond term 25 being divided by their common meaſure 5, the three new terms in the third rank, will be 9. 5. 1. Laſtly working with theſe as the Rule of Three inverſe requires, the anſwer to the queſtion will be 45.

19. In the Rule of Three direct or inverſe, when the Diviſor and either of the other two terms are fractions, having a common denominator, the ſaid denominators may be rejected, and their numerators retained as new terms: Example, if $\frac{3}{4}$ of an Ell coſt 65 pence, what ſhall $\frac{7}{4}$ coſt, the anſwer will be found 91 pence, and the work will ſtand as here you ſee.

1/4	65	7/4	
5	65	7	
1	13	7	(91.

20. In the rule of three direct or inverse, when one of the given terms is a fraction, if it be not the Divisor, the Divisor may be turned into a fraction having the same denominator; or if the Divisor only be a fraction, one of the other terms may be turned into a fraction having the same denominator; and in either case the common denominators may be cancelled.

An Example of the first case may be this; if 12 Yards in length will make a Cloak, the stuff or Cloth being 3/4 of a Yard broad; how much Stuff of one Yard broad will make a Cloak of the same length and compass? Answer, 9 Yards.

Rule of 3 inverse.	1/4	12	1	
	3/4	12	4/3	
	3	12	4	16/4 or 9 Yards

An Example of the second case. If 7/4 of a yard cost 16 shillings, what shall one Yard cost? Answer

	Yard			
Rule of 3 direct.	7/4	16	1	
	7/4	16	4/7	
	7	16	8	(18 4/7

CHAP.

CHAP. XXIV.

Of the double Golden Rule.

1. IN the two laſt Chapters I have ſhewed the nature of the ſingle Golden Rule, with the ordinary and the practical manner of working the ſame: I come now to ſpeak of the compounded Golden Rule.

2. The compounded Golden Rule or rule of Proportion is, when more than three terms are propounded.

3. Under the compounded Golden Rule, is comprehended the double Golden Rule, and divers Rules of plural Proportion.

4. The double Golden Rule is, when five terms being propounded, a ſixt in proportion to them is demanded: the greateſt difficulty whereof is in placing of the terms; for which obſerve, as in the former Rule of Three,

1. That the firſt and third numbers muſt be both of one kind.

2. That the two firſt terms in the queſtion do conſiſt of a ſuppoſition, and the third of a demand.

Example, if 100l. gain 6 pound in 12 months, how much will 65 pounds gain in 8 months?

Here you ſee the ſuppoſition is, If 100l. gain 6; the demand is, how much will 65 pounds gain: & therefore theſe terms muſt ſtand thus, 100 6 65 and the other two terms muſt be ſet un- 12 8

der

der the numbers to which they have relation, the 12 months under 100, and the 8 months under 65.

5. The terms of the queſtion being thus placed, a reſolution may be made, either by two ſingle Rules of Three, or by one Rule of Three compounded of the five numbers given.

6. If you make the reſolution by two ſingle Rules of Three, you muſt conſider, whether the terms in both Rules be in a direct proportion or not, by obſerving whether the Demand be more or leſs, as hath been taught in the ſingle rule of Three; in this example they are both direct, and the proportions are,

1. As the uppermoſt term of the firſt place, is to the middle term; ſo is the uppermoſt term of the laſt place to a fourth number.

2. As the lower term of the firſt place, is to that fourth number, ſo is the lower term of the laſt place to the term required.

See in the example before ſet down; uſing the lower term of the firſt place as a common number in the firſt proportion ſay, If 100 pounds gain 6 pounds in 12 months, how much will 65 pounds gain, in the ſame time: which being a direct proportion, the fourth term proceeding from the ſaid 3 given numbers 100. 6. 65 is 3. 90.

Again, to find the term required, uſing the uppermoſt term of the third place, as a common number in this proportion, I ſay, 2. If in 12 months 65 pounds gain 3. 90, how much would 65 pounds gain in 8 months, which being alſo a direct proportion, the fourth proportional proceeding from the ſaid 3 numbers given 12. 3. 90. 8. is 2. 60. So I

conclude that if 100 pounds gain 6 pounds in 12 months, 65 pounds will gain 2. 60 pounds in 8 months, as you may obſerve by the work.

```
100 —— 6 —— 65
 12          8
-------------
100 —— 6 —— 65
             6
        -------
        3. 90
```

```
12.   3.90 —— 8
         8
      -----
      3120 (2.60
      24
      ---
       720
       72
       ---
       000
```

7. But to reſolve this queſtion by one Rule of Three compounded of the five numbers given, they being placed as hath been already directed, you muſt take the product of the two numbers in the firſt place for the firſt term; and the product of the two numbers in the laſt place for the third term, then working as in the ſingle Rule of Three the anſwer will be 2. 60. as before, as by the operation doth appear.

100 — 6 — 65
12 8
1200 — 6 — 520
6

3120
2400 (2.6

7200
7200

8. A ſecond queſtion or example may be this. If 8 Clerks write 154 ſheets in 6 days, how many Clerks will write 462 ſheets in 12 days?

Here the ſuppoſition is, if 154 ſheets be writ in 6 days; the demand is, in what time 462 ſheets may be writ; the terms of the queſtion muſt therefore ſtand thus.

Sheets	Clerks	Sheets.	
154	8	462	(24
6		12	

And then to reſolve this queſtion by two ſingle Rules of Three, according to the directions of the fifth Rule of this Chapter, I ſay: by the Rule of 3 direct,

If 154 ſheets canbe writ by 8 Clerks in 6 days, How many Clerks will write 462 ſheets in that time, and the fourth term proceeding from the ſaid 3 numbers given 154. 8. 462 is 24.

2. I ſay, if 24 Clerks write 462 ſheets in 6 days, how many Clerks will write the ſame number of ſheets in 12 days? Now here more time being allowed a leſſer number of Clerks will ſerve to do the work; and therefore by the Rule of Three inverſe, the fourth term proceeding from the ſaid 3 numbers given 6 24 12 is 7 12; ſo I conclude, if 8 Clerks write 154 ſheets in 6 days, that 7 Clerks will write 462 ſheets in 12 days, as by the work appeareth.

Sheets	Clerks	Sheets
154	8	462
6		12

154.	8.	462		6.	24.	12
		8			6	
		3696	(24	12)	144.	(12
		308				
		616				
		616				

9. But to reſolve this queſtion by one rule of Three compounded of the five numbers given, they being placed as before, one of the ſingle Rules being inverſe, you muſt multiply the lower numbers in the firſt and laſt terms, by the upper numbers croſs wiſe, that is the upper number of the firſt term, by the lower number of the laſt, and the uppermoſt of the laſt terms by the lower of the

the first, and write each product under the lower term by which it is produced; and then if the inverse proportion be found in the uppermost line using those products as single terms, proceed to find the term required by the single Rule of Three direct: but in case you find the inverse proportion in the lower line, perform the work by the single Rule of Three inverse. So in this example the terms standing as before, I multiply 154 by 12 and the product 1848 I set under 12: again I multiply 462 by 6, and the product 2772 I set under 6, then because the inverse proportion is in the lower line, I proceed to find the fourth term required, by the Rule of Three inverse, and find the fourth proportion all, from the 3 given numbers 2772. 8. 1848 to be 12, as by the following work appears.

154	8	462	
6		12	
2772		308	
8		154	
22176		1848	(12
1848			
3696			
3696			

But the terms of this question being so ordered as that the uppermost numbers in the first and last places be set in the place of the lower, and the lower

lower in the place of the first, the inverse proportion will be found in the upper line, and then working by 2 single rules of three, the fourth proceeding by an inverted proportion from the said three numbers given 6. 8. 12 will be 4.

And the fourth term proceeding from the 3 given numbers 154. 4. 462 in a direct proportion, will be 12, as by the work appeareth.

6 —— 8 —— 12

154 462

6	8	12	154	4	462
	6				4
12)	48 (4	154)		1848 (12	
	48			154	
	00			308	
				308	
				000	

Again the resolution of this question by one rule of three compounded of the five numbers thus placed will be by a direct proportion, because the inverted proportion is in the first line, as by the work appeareth.

6 — 8 — 12

154 462

308 2772

154 8

1848) 22176 (12

1848

3696

3696

0000

CHAP. XXV.

Of the Rule of Fellowship.

1. THe Rules of plural proportion are those, by which we resolve questions, that are discoverable by more Golden Rules than one, and yet cannot be performed by the double Golden Rule mentioned in the last Chapter.

2. Of these Rules there are divers kinds and varieties according to the nature of the question propounded: for here the terms given are sometimes four, sometimes five, sometimes more, and the terms required sometimes more than one.

3. The

3. The particular Rules of plural proportion which I ſhall here treat of are theſe, the Rule of Fellowſhip, the Rule of Company, the Rule of Barter and Exchange, and the Rule of Alligation.

4. The Rule of Fellowſhip is that by which in accounts amongſt diverſe men (their ſeveral ſtocks together with the whole gain or loſs being propounded) the gain or loſs of each particular man may be diſcovered.

5. This Rule is either ſingle or double.

6. The ſingle Rule of Fellowſhip is, when the ſtocks propounded do all continue in the adventure, for equal times, that is, the one as long as the other.

7. In the ſingle Rule of Fellowſhip, the total of all the ſtocks muſt be the firſt number in the Rule of Three, the whole gain or loſs the ſecond; and each particular mans ſtock the third; and therefore the proportion is this.

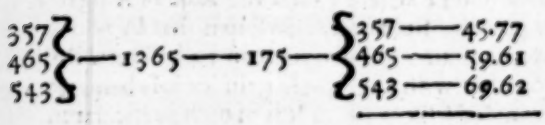
As the whole ſtock is to the whole gain or loſs, ſo is every particular mans ſtock to his particular gain or loſs: and by this proportion you muſt work as often as there are particular ſtocks in the queſtion.

Example, Three Farmers hired a Shepherd to keep their ſheep, for 8 pound 15 ſhillings *per Annum*.

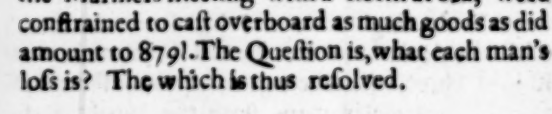
A committed to his care 357 ſheep, B 465 and C 543, I demand how much each man muſt pay of the 8 lib. 15s.

Here 357, 465 and 543 are the ſeveral ſtocks propounded, whoſe total 1365 is the firſt term: 8 lib. 15s. the ſhepherds wages is the ſecond,

and 357 the first mans stock, is the third term, in the first proprtion, and therefore I say as 1365 to 8 lib. 15 shillings, or to 1755; so is 357 to



2. Example, Four Merchants adventured to Sea a stock of 4858 pounds: A put in 2315 pounds; B put in 946 l. C put in 834 l. D put in 763 l. but the Mariners meeting with a storm at Sea, were constrained to cast overboard as much goods as did amount to 879 l. The Question is, what each man's loss is? The which is thus resolved.



8. The double Rule of Fellowship is, when every mans stock hath a relation to a particular; that is when every particular stock is multiplied by the time, for which it doth continue in Fellowship, and hath no other difference from the single Rule of Fellowship but only this, that the first number is the sum of these several products, and each particular product is the third, the whole gain or loss is

is the ſecond in both Rules, and therefore the proportion to be obſerved in the ſolution of ſuch queſtions as fall under this Rule is

As the ſum of the products found by multiplying each ſtock by its own time, is to the whole gain or loſs: ſo is each particular product, to its particular gain or loſs.

1 Example, A B and C hold a piece of ground in common, for which they are to pay 36l. 10s. 6d. Into this paſture A put in 23 Oxen 27 days, B put in 21 Oxen 35 days, and C put in 16 Oxen 23 days, the queſtion is what each man is to pay of the ſaid rent of 36 lib. 10s. 6 pence. Firſt multiply each ſtock by its own time, and the ſeveral products will be as followeth.

	Products	Total	lib.	s.	d.
A.	23 x 27 = 521	1309	36.	10.	6
B.	21 x 35 = 420				
C.	16 x 23 = 368				

And hence the particular proportions are

1309	36.525	521	14.53745
1309	36.525	420	11.71925
1309	36.525	368	10.26829
			36.52499

2. Example may be this, Three Merchants company for 18 months; A put in 500l. and at 5 months end took out 200l. and at 10 months end put in 300l. and at 14 months, took out 130 pound.

B put in 400l. and at 3 months put in more 270l. and at 7 months took out 140l. and at 12 months put in more 100l. and at 15 months took out 99l. C put in 900l. and at 6 months took out 200l. and at 11 months put in 500l. and at 13 months took out 600 pounds, and they gained 200l : I demand what each mans part of the gains comes to.

In Questions of this nature, two things are principally to be observed.

1. The whole time for Partnership.

2. The respective time belonging to each mans stock. So here it is evident that the whole time is 18 months, and the particular stocks and times belonging to each Merchant are as followeth.

A	500 lib. 5 300 lib. 5 600 lib. 4 470 lib. 4	Months.	2500 1500 2400 1880	8280
B	400 lib. 3 670 lib. 6 530 lib. 3 630 lib. 3 531 lib. 3	Months.	1200 4020 1590 1890 1593	10293
C	900 lib. 6 700 lib. 5 1200 lib. 2 600 lib. 5	Months.	5400 3500 2400 3000	14300

A.

A. 8280
B. 10293 } 32873 —— 200 { 8280 —— 50.376
C. 14300 { 10293 —— 62.623
{ 14300 —— 87.001
200.000

9. The Rule of Fellowship is proved by adding the terms required, whose sum ought to be equal to the second term in the Question, or else the whole work is erroneous.

3 Example, There is 20 shillings to be divided amongst 4 men, of which A. is to have $\frac{1}{2}$, B. $\frac{1}{3}$, C. $\frac{1}{5}$ and D. $\frac{1}{6}$. The question is what every mans share is.

To answer this question, and those of the like nature, these fractions $\frac{1}{2}$ $\frac{1}{3}$ $\frac{1}{5}$ and $\frac{1}{6}$ must be reduced to fractions of one and the same denomination, as hath been shewed in the 9th rule of the 12th Chapter; so will $\frac{1}{2}$ be equal to $\frac{120}{240}$, $\frac{1}{3}$ will be equal to $\frac{80}{240}$, $\frac{1}{5}$ will be equal to $\frac{72}{240}$ and $\frac{1}{6}$ will be equal to $\frac{60}{240}$. Now then neglecting the denominators the sum of the numerators will be, and then the question may be resolved as here you see.

342 { 120, 90, 72, 60 } 240 { 84. 72. / 63. 54. / 50. 180. / 42. 36. } 342.

which being added make 240 pence.

CHAP. XXVI.

Of the Rule for the exchange of Coyns, Weights and Measures.

1. THe rate and proportion between Coyns Weights and Measures of different kinds being known, either from some good Author, or rather by experience, it will be easie for such as understand the Rule of Three, to convert one Species into another; when the question concerns no more than two or three sorts: but when the comparison is made between more than three, one single Rule of three without some other help will not resolve the question.

2. Now because there is nothing more usual with Merchants and Tradesmen, than to exchange the Coyn of one Country for the Coyn of the like value in another, and in like manner to Barter for commodities of different weights and measures, I will here shew how such exchange or Barter is to be computed, and then especially when more is required to resolve the question, than one single Rule of Three only.

3. The questions of this kind being all resolvable either by one single Rule of Three; or by the Rule of Three often repeated; there needs no other directions, than what hath been already given in the Rule of Three, to wit, that care be had to make the first and third numbers of one kind, that is, if the first be sterling mony, the third must be

be ſo too; if the firſt be Flemiſh, the third muſt be Flemiſh. Example, How much Flemiſh mony muſt be received for 340 lib. Sterling; every 20 ſhillings ſterling being valued at 34 ſhillings 7 pence Flemiſh; here the proportion is.

	s.	Flemiſh	ſter.	Flemiſh
As	20	34s. 7d.	340 lib.	

Or reducing the 34s. 7d. Flemiſh into a decimal.

	s.	Flemiſh	ſter.	Flemiſh
	1	1.729166	340	587.916440

That is 587 lib. 18 ſhillings 4 pence, that is 45 lib. 12s. ſterling.

		Spaniſh Piſtolet,	ſter.	Spaniſh Piſtolet
2.	As $\frac{73}{5}$	1	$\frac{340}{5}$	$62\frac{34}{73}$

But if the terms be placed according to the following directions, this and all other queſtions of the like nature may be reſolved by one ſingle Rule of Three.

1 Spaniſh Piſtolet = $\frac{73}{5}$ ſhillings ſterling.
$\frac{33}{5}$ ſhillings ſterling = 1 Crown Genoa.
120 Crowns Genoa = Spaniſh Piſtolets.

Which order of placing the ſaid given numbers being obſerved,

2. Example, If 1 Spaniſh Piſtolet be equal in value to $14\frac{1}{5}$ ſhillings ſterling; and $7\frac{1}{2}$ ſhillings ſterling

ling equal to 1 Crown Genoa; how many Spaniſh Piſtolets are equal to 120 Crowns Genoa? For the more eaſy reſolution of this queſtion and all others of the like nature take theſe directions; ſet down the numbers which make the ſuppoſition in a Column one under another; and the numbers which anſwer the ſuppoſition right againſt them in another Column one under another alſo; then conſider whether it be required to find, how many pieces of the firſt Coin, are equal in value to a given number of pieces of the laſt Coin. Or whether it be required to find, how many pieces of the laſt Coin are equal in value to a given number of pieces of the firſt.

In the firſt caſe place the number that makes the Queſtion under the firſt Column, under the ſeveral ſuppoſitions, and in the laſt caſe place the ſaid number that makes the queſtion, in the ſecond column, under the ſeveral numbers that anſwer to the ſuppoſitions; then proceed to anſwer the queſtion by the Rule of three in this manner.

When you are to find, how many pieces of the firſt Coin are equal in value to a given number of pieces of the laſt, as in this queſtion you are, The firſt term in the Rule of Three muſt ſtill be one of the numbers in the ſecond Column; and look how many ſeveral numbers there are there, ſo often muſt the Rule of Three be repeated, which in the preſent queſtion are two: the ſecond and third terms in the firſt Rule muſt be the firſt and ſecond numbers in the firſt Column, and the fourth term in proportion to theſe three numbers given muſt be the one of the middle terms in the ſecond Rule,

and

and ſo continually, as oft as the Rule of Three ſhall be repeated: In this queſtion, the terms of the firſt proportion ſtand thus.

ſterling	Piſtolet	ſterling	Piſtolets
$7\frac{1}{2}$.	1.	$\frac{15}{2}$.	$\frac{15}{75}$.

	And then	Crown	Piſtolet
1 Crown Genoa $\frac{15}{75}$	Piſtolets	120	$\frac{4560}{75}$

that is $62\frac{60}{75}$ Piſtolets.

But the terms being placed into two Columns according to the former directions, this queſtion, and all other of the like nature, how many numbers ſoever there be in each Column, may be more briefly reſolved thus.

Multiply all the given terms in the firſt Column according to the Rule of continual Multiplication, and reſerve the laſt product for a Dividend: again, Multiply continually all the terms in the ſecond Column, ſo ſhall the laſt product be a Diviſor, and the Quotient ariſing from this Dividend and Diviſor, ſhall be the anſwer deſired.

In this preſent queſtion the numbers in the firſt Column are, 1 $\frac{15}{2}$. 120. and the product of them is $\frac{4560}{2}$ which being divided by $\frac{75}{2}$ the product of the numbers in the ſecond Column, the Quotient is $62\frac{60}{75}$, as before.

But if the queſtion had been, how many pieces of the laſt Coin were equal in value to a given number of the firſt, that is, how many Crowns Genoa were equal to 120 Spaniſh Piſtolets, the laſt number 120 Piſtolets, muſt have been placed in the ſecond Column, as here you ſee.

1 Column

1. Column		2. Column
1 Spaniſh Piſtolet	=	$7\frac{1}{5}$ ſhillings ſterling.
$38\frac{8}{5}$ ſhillings ſterling	=	1 Crown Genoa.
Crown Genoa	=	120 Spaniſh Piſtolets.

And then to reſolve this queſtion by two Rules of Three in the ordinary way; the firſt in the ſecond Column muſt be the firſt term, in the firſt Rule, and the firſt and ſecond numbers in the firſt Column, muſt be the ſecond and third terms as before; and the fourth proportional ariſing from thoſe three numbers given, muſt be one of the firſt terms in the ſecond, to which the ſecond number in the ſecond Column muſt be one of the middle terms in the laſt proportion.

Ster.	Piſtolet.	Ster.	Piſtolet.
$7\frac{1}{5}$	1	$38\frac{8}{5}$	$5\frac{8}{11}$

	Piſtolet	Crown Genoa	Piſtolet	Crown Genoa.
2.	$\frac{78}{11}$	1	$\frac{120}{1}$	$23\cdot\frac{40}{11}$

Note, That when the ſame numbers happen to be multiplicators in the Dividend and alſo in the Diviſor, ſuch multiplicators may be neglected in both, and much labour in queſtions of this nature may be many times ſaved; and then the two proportions will be as here you ſee them; and how oft ſoever the Rule of Three muſt be repeated, you muſt proceed as in the former directions till you come to the laſt, and then make the laſt term fourth proportional

portional, to be the first term in the last Rule of three, and by that dividing the product of the second and third terms, the quotient shall be the answer required; as by the operation it doth appear.

Or thus: Multiply $7\frac{1}{2}$. 1. 120 the numbers in the second Column continually, so will the product be $876\frac{0}{7}$ for a dividend, and the numbers in the first Column 1. $3\frac{8}{5}$ being almost multiplied together the product is $\frac{38}{5}$ for a Divisor, and the quotient arising thence is $\frac{4380}{190}$ or $23\frac{10}{19}$.

3. Example: If 27 Ducatons Florence, be equal in value to 5 lib. 19 shillings, 3 pence sterling, and 4 lib. 5 shil. 4 pence sterling, equal to 16 Crowns at Lyons; how many Ducatons Florence are equal to 43 Crowns at Lyons? The numbers being placed according to the former directions will stand thus.

27 Ducatons = 5 lib. 19 shillings, 3 pence sterl.
4l. 5s. 4d. sterling = 16 Crowns Lyons.
43 Crowns Lyons = Ducatons Florence.

The which question by two Rules of Three is thus resolved.

Pence ster.	Ducatons	d. sterling	Ducatons
1431	27	1024	19.32075

Crowns Lyons	Ducatons	Crityons	Ducatons
16	19.32075	43	51.9245

Or thus: 1431 multiplied by 16, the product is 22896;

22896 and 27. 1024. 43 being multiplied continually the product is 1188864, which being divided by the former Product the quotient is 51.9245 Ducatons as before.

But if the question had been, how many Crowns Lyons are equal to 27 Ducatons; the second proportion would have been 19. 32075. 16. 43. 35. 60937: Or the product of 1431. 16. 43 is 984528, and the product of 1024. 27 is 27648, by which dividing the former product the quotient is 35. 60937.

4. Example: If $\frac{1}{3}$ Pistolet of Spain be valued at 3l. 13s. 6d. Tournois, 6l. Tournois at 141 Flemish, 28l. 14s. 7d. Flemish at 24l. 12s. 6d. sterling, how many Pistolets ought I to receive for 27l. 6s. 9d. sterling? Answer 98 $\frac{41}{57}$ Pistolets. For

	Tournois	Pistolet	Tournois	Pistolets
1.	147s.	1	120s.	$\frac{120}{147}$ or $\frac{40}{49}$

	Flem.	Pistolets	Flem.	Pistolets
2.	$\frac{168}{55}$	$\frac{40}{49}$	$\frac{6897}{55}$	$\frac{497218}{24157}$

that is 33 $\frac{7}{147}$ Pistolets. Lastly

	Flem.	Pistolets	Flem.	Pistolets
3.	$\frac{1970}{9}$	$\frac{4915}{147}$	$\frac{3787}{9}$	$\frac{484462}{21315}$

or 98 $\frac{41}{57}$ Pistolets.

Or placing the terms according to the former directions they will stand thus.

1 Pistolet

1. Piſtolet = 1764d. Tournois.
1440d. Tourn. = 168d. Flemiſh.
6895d. Flem. = 5910d. ſterling.
17361d. ſter. = Piſtolets.

The product of 1764. 168. 5910 being multiplied continually is 1751440320. And the numbers 17361. 6895. 1440 being multiplied continually, the product is 172373896806; which being divided by the former product, the Quotient is 98 $\frac{71271144}{1751440320}$ or 98 $\frac{41}{247}$ as before.

5. Example ſhall be of ſeveral meaſures compared with one another.

Suppoſitions, { 45 Ells of *Norimberg* = 36 at *Vienna*. / 17 Ells of *Vienna* = 21 at *Venice* / 280 Ells of *Venice* = 208 at *Colen*.
Queſtion, 95 Ells of *Colen* = *Norimberg*.

The numbers in the firſt Column 4517. 180. 95 being multiplied continually, the product is 130 81500. And the numbers 36. 21. 208 in the ſecond Column being alſo multiplied continually the product is 157248, by which dividing the former product, the quotient 83. 1902 is the number of Ells at *Norimberg*, equal to 95 Ells at *Colen*.

6. *Example*

6. Example.

15 lib. *Averdup. London.* = 13 $\frac{17}{21}$ lib. *Amsterdam.*
60 lib. *Amsterdam* = 65$\frac{1}{2}$ at *Bruges.*
122$\frac{1}{2}$ at *Bruges* = 145 at *Dentzick.*
Dentzick = 112 at *London.*
11825) 1436022 (130.251. *Dentzick.*

7. Example, May 1. 1669. A Merchant stocked his Factor with 1000 lib. sterling and 64 pieces of Cloth, Worcester Whites 38 Ells English in every piece, and 16 shillings sterling by the Ell, all which the Factor in way of Traffique disposeth of in manner following.

942 lib. sterling = 2355 Ells of Taffity *London.*
1547 Ells Taffity = 045 Pipes of Wine
015 Pipes of Wine = 0173 pieces of Dowlace
0138 pieces of Dowlace = 55 pieces of Holland

---

64 pieces of Cloth = 275 Spanish Pistolets.
198 Spanish Pistolets = 5821 Florins.
275 Florins = 114158 lib. Flemish.
114. 158 lib. Flem. =

November 17. 1669. The Merchant and his Factor are to come to Ballance. The question is twofold.

1. What the Factor hath remaining in his hands?

2. What it is worth in pounds sterling?

To

To the first the Factor is Debtor	Ells
Imprimis for *London* Ells of Taffity	808
Item pieces of Dowlace	35
Item pounds Sterling	58
Item pieces of Holland	55
Item Spanish Pistolets	77
Item Florins	5546
Item pounds Flemish	114. 358

To find the value of 808 Ells of Taffity.

Ells Taffity	ster.	Taffity	lib.	
2355	942	808	323	2 sterling

that is 323 lib. 4 shillings.

Then to find the value of the 35 pieces of Dowlace in pounds sterling. The terms of the questions will stand thus.

942 lib. sterling = 2355 Ells Taffity
1547 Ells Taffity = 15 Pipes of Wine
15 Pipes = 173 pieces of Dowlace
35 pieces Dowlace = pounds sterling.

Here according to the Method prescribed, the four numbers in the first Column 942. 1547. 15. 35 being multiplied continually the product is 765053850, for a dividend, and the numbers in the second Column 2355. 15. 173, being also multiplied continually the product is 6111225 for a Divisor, and the quotient arising from these two products is 25. 1882 lib. sterling for the value of the 30 pieces of Dowlace.

But because that one of the numbers in the first

Column is the ſame with one of the numbers in the ſecond, according to the note at the end of the ſecond example, that number may be neglected in both, and then the numbers in the firſt Column are 942. 1547. 35, which being multiplied continually the product is 51093590 for a Dividend, and the numbers in the ſecond Column to be multiplied are 2355. 173, and their product is 407415 for a Diviſor, and the quotient ariſing from theſe two numbers is 125. 1882 pounds ſterling as before.

3. To find the value of the 55 pieces of Holland. The terms of the queſtion will ſtand thus.

942 lib. ſterling = 2355 Ells of Taffity
1547 Ells of Taffity = 15 Pipes of Wine
15 Pipes of Wine = 173 pieces of Dowlace
138 pieces of Dowl. = 55 pieces of Holland
55 pieces of Holland = pounds ſterling.

Here the 15 Pipes of Wine, and the 55 pieces of Holland may be neglected in both Columns, and then the numbers to be multiplied in the firſt Column are 942. 1547. 138, and the product of them is 201103872, and the numbers in the ſecond Column are 2355. 173, and the product 407415 as before, and the quotient ariſing from theſe numbers is 493. 6092 pounds ſterling, which is the value of the 55 pieces of Holland.

The

The Factor then hath in his hands.

Imprimis ready mony of the 100l.	58.0000
Item 808 Ells of Taffity worth	323 2000
Item 35 pieces of Dowlace worth	125.1882
Item 55 pieces of Holland worth	493.6092
That is 999 lib. 19 ſhil. and 11 ½ pence	999.9974

The account for the 64 pieces of Cloth which coſt 30.4 pounds ſterling *per* piece, that is in all 1945.6 lib. ſter. is thus: firſt then for the worth of the 77 Piſtolets.

Piſtolet	ſter.		Piſt.	ſter.
275.	1945.	6	77	544.768

Secondly for the worth of the 5546 Florins. The terms of the queſtion will ſtand thus.

1945.6 lib. ſterling = 275 Spaniſh Piſtolets
198 Span. Piſto. = 5821 Florins
5546 Florins = lib. ſterling.

Here the numbers in the firſt Column to be multiplied together are 1945. 6. 198. 5546, and the product is 21364789248 for the Dividend, and the numbers in the ſecond Column to be multiplied are 275.5821, whoſe product is 1600775 for the Diviſor, and the quotient ariſing from theſe two products is 1334.6528 which is the value of 5546 Florins in pounds ſterling.

Lastly for the worth of 114.158 Flemish, the terms of the question will stand thus.

1945.6 lib. sterling = 274 Spanish Pistolets
198 Spanish Pisto. = 5821 Florins
275 Florins = 114.158 lib. Flemish
114.158 lib. Flem = pounds sterling.

Where neglecting the 275 Pistolets in one Column and 275 Florins in the other and 114.158 lib. Flemish, in both, the numbers in the first Column to be multiplied are 1945.6 and 198, whose product is 3852288 for the Dividend, and 5821 in the other Column is the Divisor, and the quotient arising from two numbers is 66.1791 lib. sterling for the value of 114.158 lib. Flem.

So that for the 64 pieces of Cloth the Factor hath in his hands.

	Sterling
Imprimis 77 Pistolets worth	544.7680
Item 5546 Florins worth	1334.6528
Item 114.158 lib. Flemish, worth	66.1791
And the ballance is	1945.5999

CHAP. XXVII.

The Rule of Alligation.

1. ALligation is an Art, by which we reſolve queſtions that concern the mixing of divers ſimples together.

2. Alligation is twofold Medial, and Alternate.

3. Alligation Medial is, when the ſeveral quantities and rates of divers ſimples being, we find out a mean rate for which a mixture made of theſe ſimples may be afforded: to effect this, the ſum of the quantities being given with the value of all the ſimples, the proportion is.

As the ſum of the quantities
Is to the value of all the ſimples,
So is any part of the mixture propounded
To the mean rate that is required.

Example: let 12 Gallons of Canary at 4 ſhil. the Gallon, 36 Gallons of Sherry at 3 ſhillings the Gallon, and 52 Gallons of White-Wine, at 2 ſhillings 8 pence the Gallon be mixt together; and let the price of one Gallon of that mixture be required. The ſum of 12, 36 and 52 Gallons is 100 Gallons: and the value of 12 Gallons of Canary at 4 ſhillings or 48 pence by the Gallon is 576d. the value of 36 Gallons of Sherry at 3 ſhil. or 36 pence is 1296d. and the value of 52 Gallons of White-Wine at 2 ſhillings 8 pence the Gallon, or 32 pence is 1664 pence; and all theſe values ad-

ded together do make in the whole, 3536d. Now then by the Rule of Three.

100. 3536 1 35 $\frac{36}{100}$ that is 35 pence, and 36 hundreds of a penny.

For proof of the work, compare the total value of the several simples, with the value of the whole mixture; if their sums agree the work is true as in this example.

	l	s	d
The value of 12 Gallons of Canary at 4 shillings *per* Gallon is	2	08	00
The value of 36 Gallons of Sherry at 3 shillings the Gallon is	5	08	00
And the value of 52 Gallons of White Wine at 2 shil. 8 pence the Gallon is	6	18	08
All which amount to	14	14	08

And the value of 100 Gallons at 35d. and 36 hundreds of a penny by the Gallon is 14 14 08 as before.

5. Alligation Alternate is, when several rates of divers simples being given, such a mixture is required, as may be sold at a certain mean rate propounded.

6. Alligation Alternate is either partial or total.

7. Alternation partial is, when the several rates of divers simples, with the quantity of one of them is given, and the several quantities of the rest are required, in such sort that a mixture being made according

according to the given quantities, and the quantities ſo found, that mixture may bear a certain rate propounded.

8. Alternation total is, when the total quantity of all the ſimples with their ſeveral rates being given, we find out their ſeveral quantities, in ſuch ſort, as that a mixture of them being made according to the quantities ſo found, that mixture may bear a certain mean rate propounded.

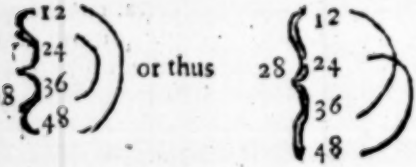
9. In both theſe kinds of alternation, there is ſome preparation to be made, before the Rules by which ſuch queſtions may be reſolved can be well delivered.

10. The preparation to be made doth partly conſiſt in placing the given rates of the things propounded and taking the differences between thoſe rates, and the mean price you would have them bear.

11. The given rates of the things propounded muſt be placed one under another ſo as that they may orderly increaſe or decreaſe, and the mean price that you would have them bear, may ſtand on the right hand of the rank about the middle: For example, let the given rates be 12.24.36.48. and the mean price 28d. which being placed one under another deſcending I draw a line of connexion, and on the left hand thereof I ſet 28 by the mean price by it ſelf, as here you ſee. The terms being thus ranked in their due order, link them together by certain arches, in ſuch ſort, as that one that is greater than the mean price, may be ſtill coupled with another that is

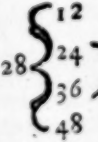
12
24
28
36
48

leſs, ſo in the premiſed example 12 may be linked with 36 or 48, and 24 may be linked with 48 or 36, and the work will ſtand thus.



The terms being thus ranked and linked together, proceed to find the differences, between the given rates and the mean price, and write that difference juſt againſt his reſpective yoke-fellow: thus the difference between 12 and 28 being 16, I place 16 againſt 48 its reſpective yoke-fellow; and the difference between 24 and 28 being 4, I place 4 againſt 36: the difference between 28 and 36 being 8, I place 8 againſt 24: laſtly 20 being the difference between 28 and 48, I place 20 againſt 12, and the work will ſtand according to the firſt way of linking the rates propounded, as here you ſee them.

But the branches being linked after the other manner the differences muſt be otherwiſe placed; for here 24 hath 48 for his Yoke-fellow, and 12 hath 36 for his.

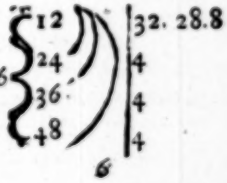


3

12. And

12. And many times it ſo falls out, that one of the given rates, may be linked with two or more of the other rates given, in which caſe the differences ought to be as often ſet down, as it is or may be diverſly linked:

thus in the premiſed rates given, if you change the mean price to 16, the rates muſt be linked and the differences ſet as here you ſee them: or being 40 thus.



13. The given rates being thus ranked and linked and their differences taken, all queſtions in Alternation partial may be reſolved by this proportion.

As the difference againſt the firſt rate
Is to the ſeveral differences that are under it,
So is the quantity propounded
To the ſeveral quantities that are required.

Example, Suppoſe a man were to mix 10 buſhels of Wheat at 48 pence the buſhel, with Rye at 36d. the buſhel, Barley at 24 pence the buſhel, and Oats at 12d. the buſhel, ſo that the whole mixture may be ſold at 28d. the buſhel, the queſtion

ſtion is, how much Rye, how much Barly, and how much Oats ought to be added to the 10 buſhels of Wheat. It is evident by the differences before taken, that for every 16 buſhels of Wheat, I ought to take 4 buſhels of Rye, 8 buſhels of Barley, and 20 buſhels of Oats, and therefore I ſay

1. As 16. 4. 10. $2\frac{8}{16}$
2. As 16. 8. 10. 5
3. As 16. 20. 10. $12\frac{8}{16}$

And from hence it appears that 2 buſhels and a half of Rye, 5 buſhels of Barley, and 12 buſhels and a half of Oats being put to 10 buſhels of Wheat, when theſe ſeveral ſorts of grain do bear the prices as in the 11 rule, may be ſold one with another for 28 pence, or 2 ſhillings and 4 pence the buſhel.

Or the differences being taken according to the ſecond way of linking them expreſſing the ſame rule, I ſay

1. As 4. 16. 10. 40 buſhels of Rye.
2. As 4. 20. 10. 50 buſhels of Barley.
3. As 4. 8. 10. 10. 20 of Oats, and a mixture being made according to theſe proportions, the whole may be ſold at 2 ſhilling 4 pence the buſhel.

14. In Alternation partial, the proof is likewiſe by comparing the total value of the ſeveral ſimples, with the value of the whole mixture: ſo in the laſt example of the former rule, the total value of 10 buſhels of Wheat 40 buſhels of Rye, 50 buſhels of Barley and 20 buſhels of Oats a-

mounts

mounts to 14 pound, which is alſo the value of the whole mixture at 2 ſhillings and 4 pence the buſhel.

15. In Alternation total, the ſeveral rates and mean price, being ſo placed, and their differences taken as hath been ſhewed, all queſtions belonging thereto may be anſwered by this proportion.

As the ſum of all the differences
Is to the total quantity of all the ſimples;
So is the correſpondent difference of each rate
To the reſpective quantity of the ſame rate.

Example, A Goldſmith having diverſe ſorts of gold, *viz.* ſome of 24 Carats fine, ſome of 22 Carats, ſome of 18 Carats and ſome of 16 Carats fine, is deſirous to melt of all theſe ſorts, ſo much together, as may make a Maſs containing 60 Ounces of 21 Carats fine. The numbers being placed and differenced as hath been ſhewed, and is here expreſſed, I ſay

1. As

1. As 12. 60. 5. 25 Ounces.
2. As 12. 60. 3. 15 Ounces.
3. As 12. 60. 1. 5 Ounces.
4. As 12. 60. 3. 15 Ounces.

Whereupon I do conclude that 25 ounces of 24 Carects fine, 15 ounces of 22 Carects, 5 ounces of 18 Carects, and 15 ounces of 16 Carects fine, being all melted together, will produce a Mass of Gold containing 60 ounces of 21 Carects fine, as was required in the question propounded.

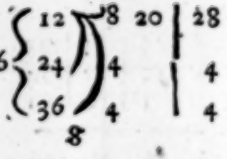
16. Here the work is true, when the sum of the quantities found are equal to the total quantity propounded: thus in the preceeding example, the quantities found were 25. 15. 5. 15. which being added together do make 60, and the quantity propounded was 60 also.

17. When a question in Alligation Alternate doth consist of three ingredients, it is capable of an infinite Series of Affirmative and Negative answers; and when the question doth consist of more than three ingredients, it is capable of as many infinite Series of affirmative and negative solutions, as you please to impose upon it.

18. In Alligation Alternate consisting of three ingredients, (their values or prices being orderly placed, and the differences between them being taken as hath been already shewed) if you take the difference of every two values, and place them against the third, you shall constitute two continual addends, and one continual subducend, that is, the two continual addends are outmost, and the

continual

continual ſubducend is inmoſt; or if you pleaſe, you may let the two outmoſt be continual ſubducends, and then the inmoſt will be a continual addend: or any three numbers in the ſame proportion will effect the ſame thing: but it is beſt to take the three leaſt numbers, that be in the ſame ratio: for example, let the value or prices of the three ingredients be 12. 24. 36, and let the mean price be 16, theſe prices being orderly placed, and the differences between them and the mean price will be as here you ſee them.



Now then deducting 12 from 24 the difference is 12, which I place againſt 36, towards the left hand, and the difference between 24 and 36 is 12 alſo, which I place againſt 12, laſtly the difference between 12 and 36 is 24, which I place againſt 24, and becauſe theſe differences are large and ſo not ſo convenient for this work, I reduce them to the leaſt numbers in the ſame proportion, and then they are 1. 2. 1. the two outmoſt to wit 1. and 1. ſhall firſt be continual addends, and the inmoſt or middle number, to wit 2, let be a continual ſubducend, and then ſome of the many anſwers that might be given to this queſtion will be theſe following.

tween A and B, let K repreſent the difference between B and C, then multiply the propoſed quantity repreſented by S by the price of the middle ingredient repreſented by B, and to the product adde the difference repreſented by K continually, until the difference repreſented by H being continually added to the value of the quantity propounded repreſented by F, ſhall make thoſe numbers to be equal: which being done, the number muſt be reſerved for a common Dividend, I call it D. The unknown quantities of A B and C, I call X. Y. Z, now then to find X, deduct F from D and divide the remainer by H.

And to find Z deduct B S from D, and d[illegible] the remainer by K, the quotients ſhall be [illegible] and Y muſt be the complement of them [illegible]

Example, ſuppoſe the prizes of the t[illegible] dients were A 5. B 7. C 10, the propo[illegible] ty S 50, and the value of that quantity [illegible] being multiplied by B 7 the product [illegible] the difference between B 7 and C 10 is [illegible] muſt be added continually unto B S 350 [illegible] ference between A 5 and B 7 is H 2 which [illegible] added continually unto F 307, which being [illegible] the common D.vidend will be D 353, as by the work appeareth.

In

In this continual addition, you must keep the least side going first, till both be equal. But if both sides will not be equal by the continual addends, which will fall out in these two cases

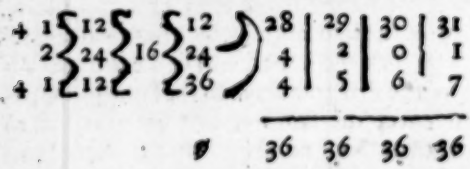
350	B S	307	F
3	K	2	H
353	D	309	
		40	20
		349	
		4	
		353	D

1. When both addends are equal, 2. When one side runs on with continually odd numbers and the other with continual even, you must make them even by taking a part of one of the continual addends: here the common [illegible]nd is D 353; from whence deducting F 307 [illegible]iner is 46, which being divided by H 2 [illegible] is X 23.

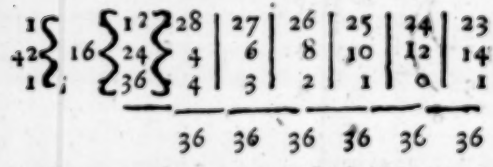
[illegible]n D 353 deducting B S 350, the re[illegible]hich being divided by K 3 the quoti[illegible] the complement of these two quo[illegible]o is Y 26: the work and proof will

	X 23	23 x 5 = 115
	Y 26	26 x 7 = 182
C 10	Z 01	01 x 10 = 10
S 50		F 307	

And to constitute the runners, the difference between A 5 and B 7 is 2, which I place against C 10, the difference between B 7 and C 10 is 3, which I place against A 5, and the difference between A 5 and C 10 is 5, which I place against B 7; and by

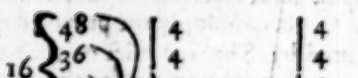


Of which the first is affirmative and the two last negatives, but maketh the two outmost to wit 1 and 1 to be continual subducends, and the inmost to wit 2 a continual addend; the answers to this question will be these following.

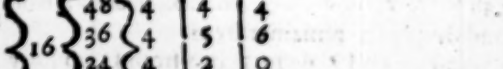


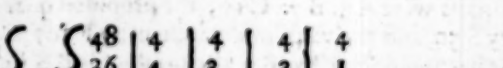
And thus you may proceed in Infinitum: but the negative answers, being improper and of no use in practice, it will be sufficient to go as far as they are affirmative and proper, taking still something of each ingredient in the question.

19. In Alligation Alternate consisting of more than three ingredients, having set down the several prices, and taken the difference between them, and the mean price, you may constitute your runners from any three that are together, and keep the other proportions for standing numbers; thus the prices of 4 Ingredients being 48. 36. 24. 12, and the mean price 16, the prices and differences will be.



And the runners for the three lower prices will be 1. 2. 1. as before and therefore, the answers these following.





20. In Alligation Alternate the prices of several ingredients being given, with the total quantity and value thereof, the several quantity of each ingredient may be otherwise found in this manner: let A. B. C. represent the prices of three ingredients, and let S. be equal to the proposed quantity of those ingredients, and F. the value of that quantity: moreover let H. represent the difference between

tween A and B, let K represent the difference between B and C, then multiply the proposed quantity represented by S by the price of the middle ingredient represented by B, and to the product adde the difference represented by K continually, until the difference represented by H being continually added to the value of the quantity propounded represented by F, shall make those numbers to be equal: which being done, the number must be reserved for a common Dividend, I call it D. The unknown quantities of A B and C, I call X. Y. Z, now then to find X, deduct F from D and divide the remainer by H.

And to find Z deduct B S from D, and divide the remainer by K, the quotients shall be X and Z, and Y must be the complement of them to S.

Example, suppose the prizes of the three ingredients were A 5. B 7. C 10, the proposed quantity S 50, and the value of that quantity F 307, S 50 being multiplied by B 7 the product is B S 350, the difference between B 7 and C 10 is K 3, which must be added continually unto B S 350; the difference between A 5 and B 7 is H 2 which must be added continually unto F 307, which being done the common Dividend will be D 353, as by the work appeareth.

In

In this continual addition, you must keep the least side going first, till both be equal. But if both sides will not be equal by the continual addends, which will fall out in these two cases

350	B S	307	F
3	K	2	H
353	D	309	
		40	20
		349	
		4	
		353	D

1. When both addends are equal, 2. When one side runs on with continually odd numbers and the other with continual even, you must make them even by taking a part of one of the continual addends: here the common Dividend is D 353; from whence deducting F 307 the remainer is 46, which being divided by H 2 the quotient is X 23.

Again from D 353 deducting B S 350, the remainer is 3, which being divided by K 3 the quotient is Z 1. Now the complement of these two quotients unto S 50 is Y 26: the work and proof will stand thus.

3	A 5	X 23	23 x 5 = 115
5	B 7	Y 26	26 x 7 = 182
2	C 10	Z 01	01 x 10 = 10
	S 50		F 307	

And to constitute the runners, the difference between A 5 and B 7 is 2, which I place against C 10, the difference between B 7 and C 10 is 3, which I place against A 5, and the difference between A 5 and C 10 is 5, which I place against B 7; and by

adding and ſubducting theſe runners to and from X. Y. Z. ſome of the many anſwers are theſe following.

+3	A 5	X 23	26	29	32	35	38	
-5	B 7	Y 26	21	16	11	6	1	
+2	C 10	Z 01	03	05	07	9	11	
	S 50		50	50	50	50	50	50

21. In Alligation Alternate when the prizes of more than three ingredients are given, you may ſet by any three at pleaſure, and upon the prizes remaining you may impoſe any part of the whole quantity propounded, leſs than the ſum of the other unknown quantities, and upon the value any ſum leſs than the value of the other unknown quantities, and let the ſum of the three quantities ſet by, be the complement of the ſum of all the unknown quantities propounded; and the value of thoſe three quantities be the complement of the value of the whole quantity propounded; this done you may proceed with the three prices ſet by as was before directed.

Example, let the given prices of the ſeveral ingredients be, A 2, B 3, C 5, D 7, E 10, and let the ſum of all their quantities be S=80, the value of all that ſum F 380; now then ſetting by C 5, D 7, E 10, impoſe upon A 2 for its quantity, T 17, and upon B 3, V 13, both theſe quantities being deducted from S 80 the remainer will be X+Y+Z=50

Then multiply T 17 by A 2, the product will be A T = 34, and V 13 by B 3, the product will be B V 39, and theſe two products being deducted from

from F 380, the remainer is the value of C X + D Y + E Z = 307: but the particular quantities of X Y Z and their particular values were before found to be as are here expreſſed.

X	23	C X =	115
Y	26	D Y =	182
Z	01	E Z =	10
S	50	F	307

The which with their runners will ſtand thus.

	2	T =	17	17	17	17	7	17
	3	V =	13	13	13	13	13	13
+3	5	X =	23	26	29	32	35	38
-5	7	Y =	26	21	16	11	06	01
+2	10	Z =	01	03	05	07	09	11
			80	80	80	80	80	80

Or placing two ſets of runners thus.

-2	2	T =	17	15	13	11	09	07
+3	3	V =	13	16	19	22	25	28
+3	5	X =	23	25	27	29	31	33
-5	7	Y =	26	21	16	11	06	01
+2	10	Z =	01	03	05	07	09	11
			80	80	80	80	80	80

If you would have the unknown quantities to

be all affirmatives, it is absolutely necessary, that the sum of all the quantities being divided by the sum of the unknown quantities, the quotient be less than the greatest, and greater than the least of the given prices; which quotient is the mean price, for which the mixture may be afforded.

22. By this last way of working such questions as do belong to Alligation Alternate, may such sporting questions be also answered, which some refer to the Rule called *Ceres* and *Virginum*; such as are these two questions following.

1. Quest. A Maid being sent to Market to buy fowl did with 20 pence buy 20 Birds, Larks for farthings a piece, Pigeons for half pence, and Chickins for groats; The question is how many she bought of a sort?

To answer this question I place the names of the birds with their several prices in this manner.

A	1	L.	2	2	} 80
B	2	P.	15	30	
C	16	C.	3	48	
				80	

Then I multiply the number of Birds, to wit 20 by 2 the middle price, and the product is 40, and the 20 pence reduced to farthings make 80; then H=B -- A *viz.* 1 I place under 80 the whole value or expence, and K=C - B *viz.* 14 I place un-

der

der 40 the product of B S as here you see: then deducted 54 from 81 the difference is 27, and twice 14 is 28, which being added to 54 the total is 82; so then twice H being added to F 80, makes that also to be 82, now then I say that the Maid bought 2 Larks and 3 Chickens which are 5, and by consequent 15 Pigeons, the truth whereof doth thus appear; 2 Larks make 2 farthings, 15 Pigeons 30 farthings, and 3 Chickens 48 farthings which being added together do make 80 the sum expended.

40	80
14	1
54	81
28	1
82	82

2. Question, A Gardener paid 20 persons 20 shillings, to every man 20 pence, to every woman 15 pence, to every boy 8 pence: The question is how many men, how many women and how many Boys?

To answer this question, I place the persons with their several rates or wages thus.

A	8	M	10	80	240
B	15	W	8	120	
C	20	M	2	40	

Then I multiply the number of persons, *viz.* 20 by 15 the middle price, and the product is B S 300, and the 20 shillings being reduced to pence do make F 240, H=B--A *viz.* 7 I place under F 240, and K=C--B *viz.* 5 I place under B S 300, the difference between these two numbers is 60, now 10 times 7 makes 70 which being added to F 240 the sum is 310, and twice 5 being added to B S 300

the ſum is 310 alſo, now then D 310--F 240=70 which being divided by H=7 quotes 10 for the number of the Boys, and D--310 BS 300=10 being divided by K5 quotes 2 for the number of men, both which make 12, and therefore the number of women muſt be 8 as by the work appears.

And here you may obſerve that ſo oft as you add H to F ſo much or ſo many you muſt take of the loweſt prices, and ſo oft as you adde K to BS, ſo much or ſo many you muſt take of the greateſt price, and what theſe two do want of the whole number, muſt be the number or quantity of the third; if there be more ingredients propounded you muſt proceed as was before directed.

CHAP. XXVIII.

Of the Rule of False.

1. HItherto *we have ſpoken or treated of poſitive Arithmetick; Negative now follows, otherwiſe called the Rule of falſe poſition*, in which by falſe terms ſuppoſed, we have a means afforded by which to diſcover the true terms required.

2. The Rule of falſe Poſition, is either ſingle or double.

3. The Rule of ſingle poſition is, when by one falſe Poſition, we may diſcover the true reſolution of the queſtion propounded.

Example, ſuppoſe 40ol. were to be diſtributed among

among three perſons, of which the ſecond man is to have three times as much as the firſt, and the third four times as much as the ſecond, the queſtion is, how much of the 400l. muſt be given to each perſon? Here you may ſuppoſe any ſum at pleaſure, and fit the proportions to it according to the ſtate of the queſtion: by this ſum ſo ſtated, a means will be afforded to anſwer the queſtion propounded, though the ſuppoſition doth not do it. Say then that the firſt man had 3 pound, the ſecond man muſt then have 9 pound, and the third 36 pound, and theſe three ſums in the total are but 48 pound, and yet by this falſe ſuppoſition, we may by the Rule of Three find out the true anſwer to the queſtion propounded.

For as $\left.\begin{matrix}3\\9\\36\end{matrix}\right\}$ ſo $\left.\begin{matrix}25\\75\\300\end{matrix}\right\}$

48 400

The firſt man then had 25l. the ſecond 75l. and the third 300l; the which ſums do together make 400l. as was propounded.

4. *The Rule of double poſition is, when two falſe poſitions are propounded, by which to diſcover the true reſolution of the queſtion.*

5. *In this Rule one ſuppoſition muſt be made at pleaſure, and examined according to the ſtate of the queſtion, whether you have gueſt right or not.*

If this ſuppoſition do not anſwer the queſtion, obſerve whether your error be in the exceſs, or in the defect.

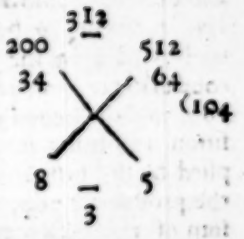
Then make another ſuppoſition and examine this ſecond poſition as you did that firſt, and if this be alſo falſe, obſerve again whether the error of this ſuppoſition be in that exceſs or in the defect, that is, whether you did ſuppoſe too much or too little; for theſe errors will either be both too much, or both too little, or one too much and the other too little, and according to this diverſity of the errors, a diverſe manner of working muſt be uſed for the reſolution of the queſtion propounded.

6. *If the errors of both ſuppoſitions, be both too little or both too much, deduct the leſs from the greater, and note the remainer for your Diviſor; then multiply the firſt poſition by the error of the ſecond, and the ſecond poſition by the error of the firſt, and deduct the leſſer product from the greater, the remainer being divided by the difference of the errors, ſhall in the quotient give you the true anſwer of the queſtion propounded.* Example, if from the half of a certain ſum of mony I take away another half, and alſo a fourth, leaving 13 pound, how much was the whole ſum? To reſolve this queſtion, firſt I ſuppoſe the whole ſum to be 40 pound, from the halt whereof to wit 20 pound, I deduct another half that is ten pound and there remaineth 10, and alſo a fourth of 20 pound, and then there remaineth 5 pound, whereas the remainer ſhould have been 13 pound, therefore this error is in the defect 8.

Secondly I ſuppoſe the whole ſum to be 64 pound the half whereof is 32, and the half of that is 16 and the fourth 8, and the remainer alſo 8, and therefore the ſecond error is alſo in the defect, and

the

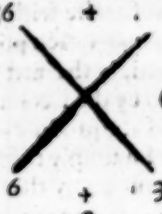
the defect is 5. the which being placed as here you see cross-wise with the errours under each position. I multiply the first position 40 by the second error 5, and the product is 200: then I multiply the second position 64 by the first error 8, and the product is 512; and the lesser product being deducted from the greater the remainer is 312, which being divided by 3 the quotient is 104 the number sought, whose half is 52, and the half of that 26, and the fourth of 52, 13, and the remainer 13 also as was required.



7. *If the errors in your suppositions, be one too much and the other too little, adde both the errors together, and the whole shall be your Divisor, then multiply your first position by your second error, and your second position by your first error as before; the sum of these products being divided by the sum of the errors shall in the quotient give you the answer to the question.*

2. Example, the same question being again propounded, for my first supposition I take 56 pounds, the half whereof is 28, and the half of 28 is 14, and the fourth 7, and so the first error is 6 in the defect; And for my second position I take 128 pound, the half whereof is 64, and half of that is 32, and the fourth 16, and so the second error is

3 too much, the sum of these errors is 9: now the first position 56 being multiplied by 3 the second error, the product is 168, and the second position 128 being multiplied by the first error 6 the product is 768, the sum of these two products is 936, which being divided by 9 the sum of the errors, the quotient is 104, the answer to the question as was desired.



And thus we have passed through all the chief parts of Natural Arithmetick, (the extraction of the square and cube roots only excepted, and that purposely omitted, because it may be not only more briefly but also more plainly shewed, in Specious or Symbolical Arithmetick) and as for artificial or Logarithmetical Arithmetick, so much as may serve to resolve all ordinary questions, hath been already shewed in my scale of interest, only the construction of the numbers themselves is there omitted, which yet I have shewed by the continual extraction of the square Root in my Mathematical institution, and by multiplication in my *Trigonometria Britanica*; since which, there are some excellent ways of making those numbers lately found out and published in Latine by *Nicholas Mercator*: so much whereof as may give thee satisfaction in that particular, I purpose God willing, to adde to a small introduction to *Specious* Arithmetick,

metick, if the Author himself find not encouragement or opportunity to do it in english himself; and that I be not suddenly prevented in the other, by some skilful hand, whose zeal for propagating the knowledge of the Arts in our own tongue, is at least equal to, if not exceeding mine.

Soli Deo Gloria.

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When each man keeps to his own Trade,
Then all things will be better made.

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Men

Men on Horſeback in Sheets.

1. The poſtures of Horſes in 4 Sheets, 2. King *Solomon*, 3. *Alexander* the Great, 4. The Black Prince, 5. King *Charles* 1. 6 King *Charles* 2. 7. Duke of *York*, 8. Duke of *Glouceſter*, 9. Duke of *Albemarle*, King *David*.

Men ſtanding in Half-ſheets.

1. The King and Queen in one Plate, 2. King alone, 3. D. of *York*, 4. D. of *Glouceſter*, 5. K. *Saul*, 6. King *David*, 7. King *Solomon*, 8. King *Joſiah*, 9. King *Manaſſes*, 10. K. *Herod*, 11. K. *Nebuchadnezzar*, 12. K. *Pharaoh*, 13. *Jephta* Judge of *Iſrael*, 14. *Gideon* Judge of *Iſrael*, 15. K. *Darius*, 16. K. *Roboam*, 17. K. *Charles* 1. in Robes, 18. K. *Ch.* 1. in Armour, 19. Prince of *Orange* and his Son, 20. Prince *Rupert*, 21. Prince of *Condy*, 22. A View of Wars late ſtrokes, 23. *Irelands* Lamentation, 24. *Charity*, 25. A Citizens Wife, 26. A waiting Gentlewoman, 27. Three ſeveral Half-Sheets of Scripture-Kings and Judges, eight in each. King of *Poland*. 2 ſeveral ways.

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1. King *Saul*, 2. King *David*, 3. King *Solomon*, 4. King *Joſiah*, 5. King *Pharaoh*, 6. K. *Herod*, 7. King *Manaſſes*, 8. Prince *Jonathan*, 9. King of *France*, 10. K. of *Denmark*, 11. K. of *Poland*, 12. Prince Elector, 13. *Hector* of *Troy*, 14. *Tamerlain* Em-

Emperour of *Tartary*, 15. All the Kings and Queens of *England*, in ſingle Half-ſheets and the black Prince.

Heads in Half-Sheets.

1. King *Charles* 1. 2. Queen *Henrietta Maria*; 3. King *Charles* 2. 4. Queen *Katharina*, 5. One of *Charles* 1. Queen *Mary*, *Charles* 2. Queen *Katharina*, Duke of *Anjou*, Princeſs *Henrietta*, and D. of *Albemarle*, and his Dutcheſs, 6. The Heads of all the Kings and Queens, from *William* the Conqueror, 7. The Heads of 24 Emperours of *Germany*, King *Charles* 1. and his Queen; *Charles* 2. Healing, and the Biſhops Crowning: Likewiſe one bigger of the Biſhops Crowning his Majeſty, and he Healing the Evil. As alſo, the Kings Armes, the beſt ſort: and indeed he hath all ſorts of ſtories and fancies for Gentlewomens works, and is doing more as faſt as time and opportunity will permit, and ſo farwel.